Printed on Thin Paper for Foreign Circulation.
"THE ENGINEER," JUNE 6, 1924.

JUN 17 1924

BRITISH EMPIRE EXHIBITION NUMBER—No. 7.

The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXXXVII.—No. 3571] LONDON: FRIDAY EVENING, JUNE 6, 1924 [PRICE {WITH SUPPLEMENTS} ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, REQUIRES—

1. STEEL BOILER TUBES for LOCOMOTIVES.
2. BRASS BOILER TUBES for LOCOMOTIVES.
3. CRANK AXLES for LOCOMOTIVES.
4. STEEL TYRES for LOCOMOTIVES.
5. HORSESHOES.
6. BRASS and IRON SCREWS for WOOD.
7. GALVANISED TUBING and FITTINGS for WATER.

Tenders due on the 17th June, 1924, for Nos. 1 and 2, on the 20th June, 1924, for Nos. 3 to 5, and on the 24th June, 1924, for Nos. 6 and 7.
Tender forms obtainable from above. 5990

Civil Service Commission.
FORTHCOMING EXAMINATION.
MALE CARTOGRAPHER in the Hydrographic Department of the Admiralty (19-25, with extension in certain cases), 10th July.
The date specified is the latest on which applications can be received. They must be made on forms to be obtained, with particulars, from the SECRETARY, Civil Service Commission, Burlington-gardens, London, W. 1. 5984

H.M. Oil Fuel Depôt, KILLINGHOLME, LINCS.

SALE OF SURPLUS STORES.
The Admiralty offer FOR SALE by TENDER the following new and second-hand SURPLUS MATERIALS :—
Heavy Cast Iron Pipes, Bends, Collars, and Specials, 4in. to 18in. diameter; Sluice Valves and Gun-metal Screwed Outlets, 4in. diameter; Expansion Joints for 8in. to 12in. mains; Jointing Rings for Flanged Pipes, 3in. to 18in. diameter; Bull-head and F.B. Rails, 54-95 lb. per yard; Light Rails, F.B. Section, 14 lb. per yard; Cast Iron Single and Check Chairs, Sleepers, Fish-plates, and Miscellaneous Railway Materials; 2800 Feet Miscellaneous Wrot. Deal Mouldings; 14in. Wrot. Iron Tubes and Fittings; Miscellaneous Ironmongery and Plumbers' Brasswork; Stocks and Dies in sets; "Flottmann" Steam Drill and Fittings; Iron Pulley Blocks; Fire-bricks and Lumps; Drain Pipes and Sundries.
The stores can be viewed at the depot on application at the Works Dept. Office.
A detailed list of the stores and form of Tender can be obtained at the Depot, and also from the Officer-in-Charge of Works, H.M. Training Establishment, Shotley, near Ipswich.
Tenders will be returnable to the OFFICER-IN-CHARGE of WORKS, H.M. Training Establishment, Shotley, near Ipswich, by Noon on Friday, 27th June. 5937

Engineering Exhibition.
UNDER THE AUSPICES OF THE SOUTH WALES INSTITUTE OF ENGINEERS.
DRILL HALL (DUMFRIES-PLACE), CARDIFF,
NOVEMBER 27TH TO DECEMBER 6TH, 1924
(both dates inclusive).
The Council of the South Wales Institute of Engineers invites applications for space in the above Exhibition. The last date for receiving applications is August 30th, 1924.
The Drill Hall has been booked from November 26th to December 13th, so as to allow sufficient time for the erection and removal of exhibits.
The Exhibition will be open from 2 p.m. to 8 p.m. each day, except Friday, December the 5th, when it will close at 6 p.m.

SCHEDULE OF EXHIBITS.
RECORDING INSTRUMENTS, &c.
Scientific, Measuring, and Recording Instruments, as applied to all branches of Engineering.
STEAM SECTION.
Water Softening and Cooling Plant.
Boilers and Equipment.
Pipes, Valves, Separators, &c.
Drawings or Models of Modern Engines.
Governors and Safety Devices, &c.
ELECTRICAL SECTION.
Motors of various kinds and Models of Winders.
Switchgear, Cables, Controllers, &c.
Electrical Tools and other Appliances.
Overhead Lines.
Small Motors.
Electric Cranes.
Telephone and Wireless Apparatus, &c.
MECHANICAL SECTION.
Mechanical Transmission of Power above and below ground, and Plant and Equipment connected therewith.
Bearings, Clutches, Ropes, Belts, Gearing, &c.
Air Compressing Plant.
WORKSHOP APPLIANCES.
Machine Tools (Small).
Pneumatic Tools.
Hydraulic Tools, &c. &c.
GENERAL SECTION.
Shaft Signalling.
Devices to Prevent Overwinding.
Models of Pit Cages, Tram Tippings, and Decking Devices.
Models of Coke Ovens, By-product and Recovery Plant.
Coal-cutting and Conveying Machines.
Pumping Plant.
Models of Screening, Coal Washing, and Stone Dusting Plant.
Couplings.
Exhibitors will be allowed to group their Exhibits on one stand when exhibiting under more than one section.
Forms of application for space, ground plan and other particulars will be forwarded on application to MARTIN PRICE, Secretary, The South Wales Institute of Engineers, Park-place, Cardiff. 5964

The Great Indian Peninsula Railway Company, 48, Copthall-avenue, London, E.C. 2, invite TENDERS for—
1. SHEFFIELD TOOLS, &c. ..... Fee 1s.
Tenders are due by 11 a.m. on 17th June, 1924. Tender forms obtainable at above address. Fees not returnable. 5956

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Swiss Electric Locomotive Types (With a Two-Page Drawing).
The British Empire Exhibition (Seventh Notice).
Main Line Electrification.
Mining and Metallurgical Congress.
American Naval Policy.
Double-Acting Marine Oil Engine—No. II.
Thermionic Valve Rectifiers.
Atoms and Isotopes.
A New Primary Battery.

PUBLIC NOTICES

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
Notice is Hereby Given that PERCY ST. GEORGE KIRKE, of Parliament Mansions, Victoria-street, Westminster, S.W. 1, SEEKS LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 140,851, granted to him for "Improvements in Waste Heat Boilers."
Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents), issued on the 28th May, 1924.
Any person or persons may give notice of Opposition to the Amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of the said Journal.
W. TEMPLE FRANKS, Comptroller-General.
5940

Birkenhead Union.
The Guardians of the Birkenhead Union invite TENDERS from Heating and Hot Water Engineers for the SUPPLY, DELIVERY and ERECTION at the Union Institution and Infirmary, Derby-road, Tranmere, Birkenhead, of approximately 250 RADIATORS, HOT WATER and HEATING PIPING, MAINS and ACCESSORIES, forming an extension of the Centralised Heating System.
Copies of the general conditions, specifications and plans and forms of Tender may be obtained from the Consulting Engineers, Messrs. Sloan and Lloyd Barnes, M.I. Mech. E., 24, Castle-street, Liverpool, on payment of a deposit of Two Guineas (£2 2s.), which deposit will be returned on receipt of a bona fide Tender.
The persons whose Tender is accepted will be required to enter into a contract with the Guardians and to provide sureties for its due performance.
The contractor in carrying out the contract will be required to pay the rate of wages and observe the hours of labour recognised and agreed upon between the employers and the trades unions in the district. He will also be required to comply with the conditions of the Unemployment Grants Committee in regard to the employment of suitable local (Birkenhead and Wallasey) unemployed persons—75 per cent. of whom must be ex-Service men.
Inquiries (if any) should be addressed to the Engineers. Tenderers are requested to furnish a statement of recent similar work carried out by them.
Canvassing the Guardians, directly or indirectly, will be deemed a disqualification.
Tenders, sealed and endorsed "Extension to Centralised Heating System," and addressed to the undersigned, must be delivered before 12 o'clock Noon on Tuesday, the 24th day of June, 1924.
By Order,
S. E. CARTER, Clerk to the Guardians.
Poor Law Offices, Conway-street, Birkenhead. 5935

County Borough of St. Helens.
REDGATE BRIDGE.
The Corporation of St. Helens are prepared to receive DESIGNS and TENDERS for the CONSTRUCTION in Steel and ERECTION of a NEW MOVABLE BRIDGE, in lieu of the existing Swing Bridge over the Canal at Redgate, within the Borough.
Plan of site and particulars may be obtained on application to Mr. Arthur W. Bradley, M. Inst. C.E., the Borough and Water Engineer, St. Helens.
Sealed Tenders, on the form and in the envelope provided, to be delivered on or before the 30th day of June.
The Corporation do not bind themselves to accept the lowest or any Tender.
W. H. ANDREW, Town Clerk.
Town Hall, St. Helens, May, 1924. 5960

PUBLIC NOTICES

Carlisle Rural District Council.
CROSBY-ON-EDEN WATER SUPPLY.
The Carlisle Rural District Council invite COMPLETE or WHOLE TENDERS from competent Contractors for the MATERIALS, PIPES, VALVES, &c., to be supplied and the work to be executed in the LAYING, MAKING and CONSTRUCTION of about 5 miles 240 yards of 3in. diameter CAST IRON GRAVITATION MAINS in the Parish of Crosby-on-Eden, in the County of Cumberland, with all necessary Valves, Hydrants, Casings, Chambers, &c., and other incidental work.
Drawings, specifications, form of Tender and bill of quantities may be inspected at the office of the Engineer, Mr. J. C. Bord, M. Inst. C.E., 18, Bank-street, Carlisle. The Engineer will supply copies of the specification and bill of quantities, &c., on the deposit of a cheque for £2, which will be returned after the receipt of a bona fide Tender with the bill fully priced out.
Sealed Tenders, addressed to the undersigned and endorsed "Tender for Crosby-on-Eden Waterworks," must be delivered not later than Noon on Wednesday, the 18th day of June, 1924.
The Council do not bind themselves to accept the lowest or any Tender.
By Order,
J. ALDERSON TOFT, Clerk to the Council.
7, Victoria-place, Carlisle,
2nd June, 1924. 5951

County Borough of Warrington.
ELECTRICITY DEPARTMENT.
The Electricity and Tramways Committee invite TENDERS for DE-AERATING PLANT (Non-Chemical Type).
Specification and form of Tender can be obtained from F. V. L. Mathias, M.I.E.E., Borough Electrical and Tramways Engineer, Howley, Warrington, on payment of One Guinea, which will be returned on receipt of a bona fide Tender. Five shillings each will be charged for extra copies of specification.
Cheques to be made payable to the Borough Treasurer, Warrington.
Tenders, addressed to the Chairman of the Electricity and Tramways Committee, Town Hall, Warrington, must be sealed with wax and endorsed "Tender for De-aerating Plant," and delivered not later than Twelve o'clock Noon on Tuesday, June 24th, 1924.
The Committee do not bind themselves to accept the lowest or any Tender.
A. T. HALLAWAY, Town Clerk.
Town Hall, Warrington. 5975

Corporation of Glasgow.
GAS DEPARTMENT.
The Corporation invite TENDERS for the SUPPLY and ERECTION of ONE 40-Ton RAILWAY WEIGH-BRIDGE at Provan Gasworks, Glasgow.
Specifications and forms of Tender may be obtained from the General Manager, Gas Department, 30, John-street, Glasgow.
Sealed Tenders, marked on the outside "Gas Department: Tender for Weighbridge," must be lodged with the Subscriber not later than Tuesday, 17th June.
The lowest or any Tender may not be accepted.
J. LINDSAY, Town Clerk.
City Chambers, 31st May, 1924 P0176

PUBLIC NOTICES

Metropolitan Water Board.
TENDERS FOR THE MANUFACTURE, DELIVERY AND FIXING OF THREE ELECTRICALLY DRIVEN RECIPROCATING AIR COMPRESSORS AND TWO ELECTRICALLY DRIVEN CENTRIFUGAL PUMPS, PIPING, FITTINGS, &c., AT WALTON PUMPING STATION, SURREY.
The Metropolitan Water Board invite TENDERS for the MANUFACTURE, DELIVERY and FIXING of THREE ELECTRICALLY DRIVEN RECIPROCATING AIR COMPRESSORS and TWO ELECTRICALLY DRIVEN CENTRIFUGAL PUMPS, PIPING, FITTINGS, &c., at the Walton Pumping Station, Surrey.
Forms of Tender, conditions of contract, specification and drawings may be inspected without payment of fee at the offices of the Board (Room 175), Chief Engineer's Department, on and after Friday, 6th June, 1924.
Contractors desirous of tendering may obtain the necessary documents from Mr. Henry E. Stilgoe, M. Inst. C.E., the Chief Engineer, on production of an official receipt for the sum of One Guinea, which sum must be deposited with the Board's Accountant, and will be returned on receipt of a bona fide Tender, together with all incidental papers. Such payments and applications must be made between the hours of 10 a.m. and 4.30 p.m. (Saturdays, 10 a.m. and 12 noon). Cheques must be made payable to the "Metropolitan Water Board," and not to individuals.
Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board, Metropolitan Water Board, 173, Rosebery-avenue, E.C. 1," and endorsed "Tender for Air Compressors, &c., Walton," must be delivered at the offices of the Board not later than 10 a.m. on Wednesday, 2nd July, 1924.
The Board do not bind themselves to accept the lowest or any Tender.
G. F. STRINGER, Clerk of the Board.
Offices of the Board, 173, Rosebery-avenue, E.C. 1, 2nd June, 1924. 5961

State Electricity Commission OF VICTORIA, MELBOURNE, VICTORIA, AUSTRALIA.
TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.
Copies of Tender form and specification will be available upon application to :—
Agent-General for Victoria, Melbourne-place, Strand, London, W.C. 2.
SPECIFICATION No. 24/45.—66,000-VOLT INSULATORS.
CHARGE.—£2 2s. for the first three copies of Tender form, conditions of contract and specification complete. This charge will be returned on receipt of a bona fide Tender. A fourth copy and any further copies will be supplied for the sum of 10s. 6d. each. This charge is not returnable.
PRELIMINARY DEPOSIT.—A preliminary deposit of £50 is to be lodged with Tender.
The specifications may be inspected at the above mentioned office.
The Commission does not bind itself to accept the lowest or any Tender.
Tenders, on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 5 p.m., 4th August, 1924.
R. LIDDELOW, Secretary.
5811

State Electricity Commission OF VICTORIA, MELBOURNE, VICTORIA, AUSTRALIA.
TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.
Copies of Tender form and specification will be available upon application to
Agent-General for Victoria, Melbourne-place, Strand, London, W.C. 2.
SPECIFICATION NO. 24/38.—BUSHING INSULATORS FOR 6600 V. TRIFURCATING BOXES.
CHARGE.—£2 2s. for the first three copies of Tender form, conditions of contract and specification complete. This charge will be returned on receipt of a bona fide Tender. A fourth copy and any further copies will be supplied for the sum of 10s. 6d. each. This charge is not returnable.
PRELIMINARY DEPOSIT.—A preliminary deposit of £10 10s. is to be lodged with Tender.
The specifications may be inspected at the above-mentioned office.
The Commission does not bind itself to accept the lowest or any Tender.
Tenders, on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 5 p.m., 15th September, 1924.
R. LIDDELOW, Secretary.
5956

PUBLIC NOTICES (continued) Page 2.

SITUATIONS OPEN, Page 2.
SITUATIONS WANTED, Page 2.
PATENTS, Page 2.
PARTNERSHIPS, Page 2.
MACHINERY, &c., WANTED Page 2.
FOR SALE, Pages 3, 4 and 96.
AUCTIONS, Pages 3 and 96.
PREMISES TO LET OR WANTED Page 3.
WORK WANTED, Page 4.
AGENCIES, Page 2.
MISCELLANEOUS, Page 2.

For Advertisement Rates see Page 631, Col. 1.

NUMERICAL INDEX TO ADVERTISEMENTS Page 97.

PUBLIC NOTICES

Tottenham District Council.

ECONOMISER FOR DISPOSAL.

OFFERS are INVITED for a GREEN'S ECONOMISER (including its REMOVAL) at present lying on the site at the Refuse Destructor Works, Park Vista-road, Tottenham. It is fitted with 160 tubes and is in good condition. Further particulars may be obtained on application to the Engineer, Town Hall, N. 15. Sealed envelopes, endorsed "Tender for Economiser," must be delivered to me not later than Twelve Noon, Tuesday, the 17th June, 1924. The Council do not bind themselves to accept the highest or any Tender.

REGINALD C. GRAVES,
Clerk and Solicitor of the Council.

3rd June, 1924.
Town Hall, Tottenham, N. 15. 5962

Tottenham District Council.

TO PERMANENT WAY CONTRACTORS.

The Council invite TENDERS for the SUPPLY of MATERIALS and the CONSTRUCTION of a RAILWAY SIDING into the Council's Refuse Destructor Works at Tottenham. General conditions, specification and form of Tender can be obtained from the Engineer of the Council on the deposit of Half-a-Guinea, which will be returned on the receipt of a bona fide Tender accompanied by the general conditions, specification, &c., otherwise the deposit will be forfeited.

Sealed Tenders, endorsed "Tender for Siding," must be delivered to me on or before Noon on Tuesday, 17th June, 1924. The Council do not bind themselves to accept the lowest or any Tender. Trade union conditions must be observed.

REGINALD C. GRAVES,
Clerk and Solicitor of the Council.

29th May, 1924.
Town Hall, Tottenham, N. 15. 5948

Victorian State Railways.

The Agent-General for Victoria, Australia, invites TENDERS for the SUPPLY and DELIVERY, c.i.f. Melbourne, fully inclusive of Australian Customs duties, &c., of the following :—

CONTRACT 36,852.

Approximately 3155 TONS 80 lb. STEEL RAILS.
2368 TONS 100 lb. STEEL RAILS.
95 TONS FISH-PLATES for 80 lb. Rails.
153 TONS FISH-PLATES for 100 lb. Rails.

Tenderers have the option of tendering f.o.b. British port basis.

Specifications, conditions of contract and forms of Tender may be obtained by bona fide tenderers at the offices of the Consulting Engineers, Messrs. John Coates and Co., Ltd., Victoria House, Melbourne-place, Strand, London, W.C. 2.

Tenders must be delivered to the Agent-General for Victoria, Victoria House, Melbourne-place, Strand, London, W.C. 2, not later than Noon on Wednesday, June 25th, marked "Tender for Steel Rails."

A preliminary deposit of ninepence per ton must accompany each Tender.

The Government does not bind itself to accept the lowest or any Tender.

Signed, JOHN McWHAE,
Agent-General for Victoria.
Victorian Government Office, London. 5960

Borough of Torquay.

WATERWORKS DEPARTMENT.

The Torquay Corporation REQUIRE the SERVICES of a CLERK OF WORKS upon the Construction of a 1½ million gallon Service Reservoir at Torquay.

Applications must be made upon the printed forms that can be obtained from the undersigned, and which must be returned on or before Saturday, June 14th, 1924.

SAMUEL C. CHAPMAN, M.Inst.C.E.,
Water Engineer.

Town Hall, Torquay.
23rd May, 1924. 5961

City of Leicester Water Department.

ASSISTANT ENGINEER.

The Water Committee are prepared to receive APPLICATIONS for the POST of ASSISTANT ENGINEER.

An inclusive salary at the rate of £490 per annum will be paid.

Applications, stating age, experience, qualifications and present salary, together with copies of not more than three testimonials, should be received by me not later than Noon, the 16th June, 1924.

Canvassing members of the Committee will disqualify applicants.

G. T. EDWARDS, M. Inst. C.E.,
Water Engineer and Manager.

Waterworks Office,
Bowling Green-street, Leicester. 5869

New Zealand.

APPLICATIONS are INVITED for an ASSISTANT CHIEF MECHANICAL ENGINEER to the New Zealand Government Railways. Commencing salary, £950 per annum, rising to £1000. Age limit, 40.

Applicants are required to have had practical experience of the Control of the Locomotive Running Branch of a Railway operated by Steam, and to have held a responsible position on a Railway equipped for Electric Traction.

Further particulars and forms of application obtainable from the HIGH COMMISSIONER FOR NEW ZEALAND, 415, Strand, London, W.C. 2, by whom completed applications will be received up to and including 21st June, 1924. 5786

SITUATIONS OPEN

WANTED, CIVIL ENGINEER, for Making Accurate Survey of Large Engineering Works in Wales; good Surveying Experience and some knowledge Works Railway Construction essential.—Write, with full particulars, to Box 140, Leathwait and Simmons, 94, Throgmorton-street, E.C. 2. P9176 A

WANTED, Efficient SALESMAN, with First-class connections, to Sell Machinery to Steel Works, Shipyards, Collieries, Works, &c. Also another MAN, to Sell Drying Machinery, &c., for Textile and other Trades. Both must have some technical knowledge and fluent German essential. Mainly commission basis.—Write, Box A484, Hutchins and Harris, Ltd., Advertising Agents, 62/63, Windsor House, Victoria-street, S.W. 1. P9168 A

ASSISTANT MANAGER, also a BRANCH MANAGER, REQUIRED for rapidly growing company producing Compressed and Liquid Gases and Machinery for such. Applicants must combine Engineering and Commercial knowledge and experience, be real live men not afraid of work, fighters and gentlemen alike.—Write, giving qualifications, experience, photograph and income required, to Box 1073, Willing's, 30, King-street, Covent Garden, W.C. 2. 5939 A

ASSISTANT WORKS MANAGER WANTED in Engineering Works, Birmingham district; must be sound practical man, resourceful and energetic, of good all-round experience and up-to-date in modern Repetition Practice. Applicants please state full particulars of career, age and salary.—Address, 5938, The Engineer Office. 5938 A

CHIEF CHEMIST (Temporary or Permanent) REQUIRED for Portland Cement Factory in Australia. Applicants must have first-class experience with Modern Rotary Kilns operating on the Thick Slurry Process. Free quarters and allowances provided.—Apply, stating fully experience, age and salary, to W. J. C., Edgar Allen and Co., Ltd., Imperial Steel Works, Sheffield. 5979 A

ELECTRICAL ENGINEER WANTED for Erection of Heavy Switchgear Plant in Russia; good knowledge of Russian language essential.—Write age, qualifications and salary required, to 5976, The Engineer Office. 5976 A

ENGINEER REQUIRED for Japan. Must have expert knowledge of Machine Tools, good education and address.—Apply by letter, stating age, experience and salary required, to THE CHAIRMAN, ASSOCIATED BRITISH MACHINE TOOL MAKERS, Ltd., 17, Grosvenor-gardens, London, S.W. 1. 5934 A

MANAGING DIRECTOR WANTED in Country Engineering Business; able to invest £1,000.—Address, P9185, The Engineer Office. P9185 A

SALES ENGINEER REQUIRED (ex-Officer with disablement pension preferred) to sell on gas, water, electricity works, factories, &c., with fleatruments with over 30 years' reputation. State full particulars, salary, experience, in confidence.—Address, Box 880, c.o. Dawson's, 116, Cannon-st., London, E.C.4. 5987 A

STEEL CASTINGS.—REPRESENTATIVE REQUIRED for Steel Foundry; capacity 300 tons per month, with available space for extension. Applicant must have influence and connection. Seat on Board may be arranged. State fullest particulars, salary required, in confidence.—Address, 5983, The Engineer Office. 5983 A

TEMPORARY JUNIOR CIVIL ENGINEERING ASSISTANT WANTED. The work immediately in prospect is Parliamentary Work and the Preparation of Street and Tramway Contract Plans calling for special and neat draughtsmanship, but structural work will probably follow. Salary at the rate of £200 to £240, according to qualifications. No testimonials or specimens to be sent in the first instance.—Apply, CITY ENGINEER, Hall, on or before 11th June. 5941 A

VACANCY for First-class STRUCTURAL DESIGNER; Steel-frame Buildings and general competitive design. Good salary to suitable man.—Address, stating age, experience and salary required, 5969, The Engineer Office. 5969 A

WORKS MANAGER (Really High-class) REQUIRED for modern Engineering Works in West Riding, Yorkshire; must have organising abilities, able to control workmen and foremen, and have held similar successful position. State fullest particulars.—Address, 5947, The Engineer Office. 5947 A

WORKS MANAGER REQUIRED for Steel Boat Works; must be a good Engineer and have experience in Boat Building.—Address, stating age, full particulars of experience and salary required, 5952, The Engineer Office. 5952 A

WANTED by an Important Firm of Electric Crane Manufacturers in their London Office, SEVERAL First-class LEADING DRAUGHTSMEN. A good wage will be paid to suitable applicants.—Address, giving full particulars of experience and state age and salary required, 5942, The Engineer Office. 5942 A

WANTED, DRAUGHTSMAN, JIG and TOOL. Must have had extensive Production Experience. State age, wage and previous employers in chronological order.—Box 401, Ashburners' Advertising Agency, 10, Piccadilly, Manchester. 5982 A

WANTED IMMEDIATELY in London (Temporarily), DRAUGHTSMAN, accustomed Steam Power Station Design, Pipework, &c.; Electrical Experience desirable.—Address, stating age, experience, salary expected and when free, 5984, The Engineer Office. 5984 A

CAPABLE DRAUGHTSMAN WANTED, Temporary, for Machine Design, London.—Address, P9180, The Engineer Office. P9180 A

DRAUGHTSMAN, CONSTRUCTIONAL STEELWORK, WANTED; leading man accustomed to Estimating, Designing and Carrying-out Work entirely; good opening for energetic young live man.—Address, giving age, wages required and when disengaged, 5980, The Engineer Office. 5980 A

DRAUGHTSMEN FOR AEROPLANE WORK.—Well-known Firm REQUIRES SEVERAL Experienced men only; good salary for competent men.—Address, 5913, The Engineer Office. 5913 A

DRAUGHTSMAN REQUIRED by Crane Makers on East Coast, well acquainted with latest practice, and capable of expeditiously Preparing Designs of Electric Jib and Overhead Cranes; must be capable of Making Own Calculations and Preparing Accurate Weights for Tendering. None but thoroughly experienced men need apply.—Age, experience, salary, when at liberty, to "DESIGNER," c.o. Rethey and Co., 11-12, Westmoreland-buildings, Aldersgate, E.C. 1. 5971 A

DRAUGHTSMEN REQUIRED TEMPORARILY for General Railway Constructional Work.—Address, stating age, experience and salary required, 5977, The Engineer Office. 5977 A

DRAUGHTSMAN WANTED, Thoroughly Experienced in the design of Colliery Electric Winding Engines and Haulage Gears (mechanical portions).—Write, stating age, experience, and salary required Box 1591, Sells Advertising Offices, Fleet-street, E.C.4. 5985 A

DRAUGHTSMAN WANTED, with Experience in the Design of Machinery for Stone Crushing, Screening and the Lay-out of Complete Plants.—State age, experience and salary required to SANDYCROFT, Ltd., Sandycroft, near Chester. 5970 A

STRUCTURAL STEELWORK. — DESIGNING DRAUGHTSMEN WANTED for Estimating Dept. of large works in N. England; must be capable of Designing on competitive basis and taking off quantities, without supervision, for Framed Buildings, Workshops and General Structural Work.—Address, stating age, experience and salary required, 5958, The Engineer Office. 5958 A

WANTED, Derby District, ELECTRIC WELDERS, Carbon Arc Process; experienced in high-pressure Steam Pipework.—Address, 5849, The Engineer Office. 5849 A

PHOTO BLUE PRINTING.—MAN WANTED, to Take Charge of Manufacturing Engineers' Blue Printing Room and Drawing Files. Knowledge of Hall's Rotary Photo-Copiers and Modern Blue Printing, Photostatic, and Reproduction Processes essential, together with experience of routine filing and card indexing.—Address, stating age, experience, and salary required, 5855, The Engineer Office. 5855 A

REQUIRED, Thoroughly Competent TUBE BENDERS, capable of bending up to 12in. tubes, with or without flanges on. Position assured for really capable man.—Address, 5848, The Engineer Office. 5848 A

SITUATIONS WANTED

ADVERTISER, a Young Mechanical Engineer, aged 21, now completing a five-year apprenticeship in Locomotive Shops, where he has had a varied experience, DESIRES ANY PROGRESSIVE POSITION.

Would welcome an opportunity to gain drawing-office experience. He has received a good general education, has matriculated, is a Student of the Institution of Mechanical Engineers, and possesses industry and initiative.

Address, P9171, The Engineer Office.
P9171 B

AMBITIOUS YOUNG ENGINEER, more than average abilities, 8 years' experience contractors, London and provinces, excellent knowledge structural steel, reinforced concrete, general building work, quantities and estimating, REQUIRES POST Consulting Engineers or Reinforced Concrete Specialists in London.—Address, P9187, The Engineer Office. P9187 B

ENGINEER, Mechanical and Electrical, 16 Years as engineer and works manager, DESIRES SIMILAR POST. Accustomed to all classes of machinery and establishment lay-out and upkeep; charge of large steam and gas power plants, electric, hydraulic and pneumatic installations.—Address, P9166, The Engineer Office. P9166 B

ENGINEER (24), 4 Years Shops, 3½ Years D.O., Experienced in steam, hydraulics, plant lay-out, furnaces, powdered fuel, DESIRES CHANGE, with prospects.—Address, P9174, The Engineer Office. P9174 B

ENGINEER (30), Shops, D.O. and Marine Experience, pumps, distillers, elec. light, installation, maintenance, B.O.T. certificate, petrol engines, hard worker, excellent refs., DESIRES POST.—Address, P9162, The Engineer Office. P9162 B

ENGINEER, Wide Experience as Works Manager, designs, sales, in machine tools, milling machinery, chilled rolls, DESIRES CHANGE; modern methods, highest references.—Address, P9183, The Engineer Office. P9183 B

INDIA.

TRAVELLER, Recently Returned from India, specialising in metals, hardware, motor accessories and paints, eleven years all through India, where he did propaganda work and opened up new business, well known to all the railways, municipal offices, jute and cotton mills, collieries and tea gardens, WOULD LIKE TO HEAR FROM INTERESTED FIRMS, with a view to proceeding out East as early as possible. Highest references.—Address, Box 5, Smith's Library, George-street, Richmond. 5963 B

WELFARE SUPERINTENDENT.—POST REQUIRED as WELFARE SUPT., with important firm. Advertiser has been in charge of Welfare Committee on leading railway abroad. Such a Committee is of great benefit in increasing the efficiency of the staff and in promoting cordial relations between employers and employed.—Address, P9177, The Engineer Office. P9177 B

DRAUGHTSMAN REQUIRES TEMPORARY SITUATION; 10 years' D.O. experience on general engineering.—CROOK, 32, Whiteheads-grove, Chelsea. P9179 B

DRAUGHTSMAN (26) DESIRES WORK in London district; locomotive, crane and excavator or general.—Address, P9184, The Engineer Office. P9184 B

MECHANIC SEEKS SITUATION, 23 Years' Experience, first-class all round man; excellent references; London district preferred.—Address, P9173, The Engineer Office. P9173 B

COMMERCIAL RECONSTRUCTIONS, LTD.

1, POST OFFICE CHAMBERS, DERBY.

Engineering undertakings reorganised by specialists.
Non-paying concerns reconstructed.
Active management where desirable.
Additional Capital in approved cases.
The fullest investigations are invited and required.

PARTNERSHIPS

IF YOU ARE SEEKING
A PARTNER or PARTNERSHIP
or wish to buy or sell a
BUSINESS or WORKS
Write:
WHEATLEY KIRK, PRICE & CO.,
46, Watling Street,
London, E.C. 4.
Established over 70 years.

PARTNER REQUIRED, with £2000-£3000, by Engineers' Supplies Merchant and Agent, City. Turnover £35,000 p.a.—ARNOLD and CO., 143, Cannon-street, E.C. 4. 5959 C

PARTNERSHIPS and ACTIVE DIRECTORSHIPS WANTED in Mechanical, Constructional, Electrical Engineers, &c., for Clients with technical experience and capital from £1000 to £20,000.—GILBERT and PRATT, 16 Walbrook, London, E.C. 4. Ex. c

TO ENGINEERS.—ACTIVE DIRECTORSHIPS, suitable for Mechanical and Structural Engineers only, are VACANT in various London companies which are earning substantial profits. Investment £5000. Salary for services, interest on capital, and share of profits. In each case audited accounts are open to full investigation.—Particulars of experience should be given.—Write Box 5191, Francis and Co., 131, Fleet-street, E.C. 4. 5937 C

MISCELLANEOUS

A WELL-KNOWN FIRM in the Midlands, with a thoroughly equipped laboratory, is PREPARED to UNDERTAKE MECHANICAL TESTING, PHOTO-MICROGRAPHICAL EXAMINATIONS, METALLURGICAL ANALYSES (Ferrous and Non-ferrous), and INDUSTRIAL WATER ANALYSES for Engineering Purposes. Fees quoted on application.—Address, LABORATORY, c.o. Thomas Russell, Clun House, Surrey-street, London, W.C. 2. 5968 F

STORAGE DEPOSITORY for Machinery, Plant and Merchandise.—For terms apply, STORES DEPT., Plant House, W. 5. 5954 I

MACHINERY, &c., WANTED.

WANTED, DIRECT-COUPLED STEAM ENGINE and BOILER, large furnace, wood fuel, modern marine type, about 30 H.P.—State makers, ages, pressure, &c., where lying, and insurance reports, to STAPLEFORD IRONWORKS, Stapleford, Notts. 5803 F

WANTED, in First-class Condition and of Recent build, 100 K.W. GENERATING SET; engines by Hellies and Morcom, 230 volt, D.C. current.—Address, 5943, The Engineer Office. 5943 F

WANTED, SECOND-HAND MARINE BOILER, 15ft. diameter by 10ft. 6in. or 11ft. long, for 180 lb.—E. V. HASLAM, 37, Side, Newcastle-on-Tyne. P9164 F

WANTED.—SET of Modern PLATE BENDING ROLLS, about 10ft. long, to bend plates up to 5-8in., top roll removable. Also MULTIPLE PUNCHING MACHINE, for perforating plates up to about 2-16in. thick; GUILLOTINE SHEARS, to shear plates 8ft. wide by 5-8in. thick; PUNCHING, SHEARING and ANGLE CROPPING MACHINE, 36in./36in. gape, to punch and shear 1in./1in.; also TWO COUNTERSINKING MACHINES and MULTIPLE DRILLING MACHINES.—JOHN P. WARD, Darlington. 5860 F

BOILERS
WILSON BOILERMAKERS, LTD. GLASGOW

EDUCATIONAL

A.M.I.C.E., A.M.I.E., B.Sc., AND ALL ENGINEERING EXAMINATIONS.—All my students have my personal attention. Thousands of successes during the past nineteen years. Courses can be commenced at any time. Please note change of address.—G. P. KNOWLES, M.B.E., B.Sc., A.M.I.C.E., &c., Parliament Mansions, Victoria-street, Westminster, S.W. 1. Ex. B

CORRESPONDENCE COURSES for Inst. C.E., Inst. Mech. E., London Univ. (Matric., Inter. and B.Sc.), personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours), Assoc. M. Inst. C.E., M.R.S.I., F.R.S.A., &c. Also Day Tuition in Office. Excellent results at all Exams. Courses may commence at any time.—6/11, Trafford Chambers, 55, South John-street, LIVERPOOL. Ex. I

SURVEYING AND LEVELLING.—EXCELLENT OPPORTUNITY to ACQUIRE thorough practical INSTRUCTION on WORK.—Address, E. MOUL, Hollybank, Woking. P8857 B

TUITION BY POST.—Inst. C.E. and I. Mech. E. Enrol now for next Exams.; 100 per cent. passes last examination. Reinforced Concrete, new comprehensive course under expert engineer, 23 9s. Write for particulars.—PENNINGTONS, University Tutors, 254, Oxford-road, Manchester. Estab. 1878 Ex.

AGENCIES

RAILWAY AND DOCK ENGINEERS

ARE REQUESTED to SEND INQUIRIES for all RAILWAY MATERIALS and ROLLING STOCK, any quantity, for all gauges, to—

"EXPORT DEPT.,"
E. H. NEAL and CO.
Plant House,
EALING, LONDON, W. 5. 5348 D

CHINA.—An ENGINEER (Resident) is DESIROUS to REPRESENT ONE or TWO FIRMS as direct representative.—Address, 5950, The Engineer Office. 5950 D

ENGINEER, M.I.M.E., with 15 Years' High-class connection in Ships' Auxiliaries, DESIRES AGENCY for first-class Makers of Main and Auxiliary Diesel Engines or Shipbuilders.—Address, P9182, The Engineer Office. P9182 D

IMPORTANT FRENCH FIRM, Government Contractors, well introduced among manufacturers, WISHES to OBTAIN the SOLE AGENCY (with or without warehousing) of A MANUFACTURER of Patented Up-to-date and Special MECHANICAL APPARATUS, MACHINERY or TOOLS (small or heavy) for Metal or Woodworking purposes. Would be responsible for accounts.

First-class references in England, U.S.A., and France.

Write, giving full particulars, to SOCIETE DES HAYES FRERES, 176, Quai de Jemmapes, Paris. P9030 D

OLD-ESTABLISHED BUSINESS, with Representative calling daily upon principal shipbuilding and engineering firms on Clydeside, is PREPARED to TAKE UP AGENCY for One or Two manufacturing firms, supplying their specialities to the forecoing trades.—Address, "CLYDE," William Porteous and Co., Advertising Agents, Glasgow. P9178 D

SHAFTING BARS, BLACK AND LATHE TURNED. GENTLEMAN, with old-established connection in Manchester, is OPEN to REPRESENT First-class MAKERS for all Lancashire.—Address, 5906, The Engineer Office. 5906 D

TO MANUFACTURERS OF SPECIALITIES WHO ARE OUT FOR BUSINESS.—We have Showrooms and Selling Organisation and can introduce any good speciality.—BARRONS, 148, Curtain-road, London, E.C. 2. P9175 D

ECONOMY IN BUYING.

TWO MEN, of Wide Experience, with Office in City, invite enquiries from Home and Export Firms of good standing who require BUYING AGENTS with up-to-date knowledge of Engineering Requirements.—Address, 5927, The Engineer Office. 5927 D

PATENTS

THE PROPRIETORS of LETTERS PATENT, Nos. 141,224, relating to "Improvements in TAPS for CUTTING THREADS or THREAD CUTTING"; 150,999, relating to "Improved Means for FEEDING BLANKS for METAL-WORKING MACHINES," 149,465, relating to "Improvements in SELF-OPENING THREADING DIES," and 156,585, relating to "An Improved AUTOMATIC SCREWING MACHINE," DESIRE to DISPOSE of their PATENTS or to GRANT LICENCES to interested parties on reasonable terms for the purpose of exploiting the same and ensuring their full commercial development and practical working in this country.—Inquiries to be addressed to CRUIKSHANK and FAIRWEATHER, 65-66, Chancery-lane, London, W.C. 2. 5902 H

THE PROPRIETOR of BRITISH PATENT No. 165,768, dated July 2nd, 1920, relating to "Separable Lead Propelling Mechanism for Pencils," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or OTHERWISE on reasonable terms for the purpose of EXPLOITING the above PATENT and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 5925 H

THE PROPRIETOR of BRITISH PATENTS No. 140,418, dated July 31st, 1919, relating to "Locomotive Frame," and No. 140,436, dated July 17th, 1914, relating to "Car Truck," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of exploiting the above patents and ensuring their practical working in Great Britain.—Inquiries to B. SINGER, Steger Building, Chicago, Ill. 5936 H

For continuation of Small Advertisements see page 3.

TANKS
GALVANISING & CONSTRUCTIONAL IRONWORK.
JOSEPH ASH AND SON, LIMITED,
Ren-street South, BIRMINGHAM

PRESSURE REDUCING VALVES
TEMPERATURE REGULATORS
EXPANSION STEAM TRAPS.
THE STEAM FITTINGS CO., LTD., WEST DRAYTON.
Displayed Advertisement see May 30.

A Seven-Day Journal

An Electric Train Derailment.

A REPORT by Major Hall of the Ministry of Transport has just been issued concerning the circumstances that led to the derailment on March 9th of an electrically operated train at Southport, on the Lancashire and Yorkshire section of the London, Midland and Scottish Railway. The train was crossing from the up slow, across the down slow, to the up fast line. It consisted of four bogie cars. The leading car passed through the points safely, but all the wheels of the second car left the rails just after they had passed through the facing points. The curvature at this spot is considerable, and the side pressure on the right-hand rail necessarily heavy. The rail was side-worn, but, in the opinion of the permanent way staff, had two or three months' more life. It was of 95 lb. section, and had been reduced in weight to about 84 lb. per yard. The chairs were fastened by two iron spikes and two trenails, and it was found that some of them were insecure. The direct cause of the derailment was found in the latter fact, and the primary cause in the maintenance staff being insufficient. Major Hall says: "In view of the defects in maintenance brought to notice by this accident, the company will, no doubt, reconsider the question of the adequacy of the gang for the work on the section, and the desirability of maintaining it at full strength during the temporary absence of any of its members."

A New Telephone Cable.

THE London–Bristol telephone cable, which is one of the main links in the network of underground cables now in the course of construction, has just been put into service. The cable is 122 miles long, and is to provide the channel for communiction between London and the West of England. It will also enable direct communication to be established between London and Plymouth. Repeater stations at Taplow and Marlborough will divide the cable into three sections. The Taplow station will be the first of a series of large independent repeater stations for operation in connection with the national and international telephone services. It will be followed in time by similar stations at various parts in the underground network. The use of cables instead of overhead wires provides a system of communication which is practically free from damage by storms, and since the introduction of the valve repeater, the telephone cable has made considerable headway in connection with long-distance work.

The Severn Waterway Scheme.

A DEPUTATION from Birmingham, Worcester Gloucester, Bristol and Cardiff met the Minister of Transport last week, and discussed with him the proposed scheme for improving the canal system linking up the Midlands with the Severn. The Minister, while expressing his sympathy with the object in view, showed a desire to consider the scheme carefully in its details before committing himself to approval of it. He seemed particularly desirous of discovering to what extent the local authorities affected by the scheme would be prepared to assist financially towards its realisation. He also made pertinent inquiries as to the estimated capital cost involved and the probable traffic and revenue which the scheme would secure. Mr. Neville Chamberlain, who introduced the deputation, when expressing his thanks to the Minister for his reception, stated that he did not think any figures of value could possibly be produced regarding the estimated annual receipts and traffic. It may be remarked perhaps that some people hold that under no circumstances could the proposed canal system become financially self-supporting.

A High Elastic Limit Steel.

ONE of the most interesting papers read at the spring meetings of the Institution of Naval Architects was that presented by Messrs. G. W. Barr, F. G. Martin and A. T. Wall, on "A New High Elastic Limit Steel and its General Applications." This paper, which was reprinted in our issue of April 25th, gave rise to a vigorous discussion, in which the novelty of the new steel and its various properties were hotly debated. Some further particulars concerning this steel have now been given by Mr. Martin in Liverpool. The series of experiments which led up to its discovery was begun in 1916, when an investigation was made into the properties of ship plates following the wreck of one of Alfred Holt and Co.'s passenger vessels. From the experiments then made, Mr. Martin drew the conclusion that the elastic limit of steel such as is used for ship construction was too low, and, working in conjunction with David Colville and Sons, Limited, of Motherwell, he produced a mild steel which met all the mechanical tests of ordinary mild steel, but possessed a much higher elastic limit. It may now be stated that Alfred Holt and Co. are now having built a 450ft. cargo vessel by Scott's Shipbuilding and Engineering Company, Limited, Greenock, for which the new steel will be used. Mr. Martin estimates that there will be a saving of 8½ per cent., or nearly 250 tons of steel in the construction of the ship. The extra cost of the vessel will only be, we understand, from 2 to 3 per cent., which added cost should soon be covered by the augmented cargo which the vessel will carry.

The St. Paul's Bridge Scheme.

THE proposal to construct a new bridge across the river Thames in the neighbourhood of St. Paul's Cathedral is the senior of all the various schemes now being discussed for the improvement of London's cross-river traffic facilities. It has several times come close to a definite decision to proceed with it. Plans for the bridge have been prepared, and the Government stands committed to assist financially in the execution of the work. Last week the Bridge House Estates Committee of the City Corporation had actually resolved to recommend that the scheme should be proceeded with, but at the last moment a letter was received from the Minister of Transport suggesting that the bridge should not be begun until the scheme had been examined by the Advisory Committee which is to be set up under the new London Traffic Bill. Although that Bill has not yet been passed by Parliament, the Bridge Committee decided to fall in with the suggestion. The scheme thus stands suspended once more for a period this time of several months.

The Canadian Pacific Liner Empress of France.

THE Canadian Pacific liner Empress of France, which leaves Southampton to-morrow (Saturday) for Quebec, has just been reconditioned and converted for oil burning by her builders, William Beardmore and Co., Limited, of Dalmuir, Glasgow. The work occupied a little over six months, and it has included, besides alterations to the boilers and auxiliary machinery, improvements in the first and third-class accommodation. The results of the full-power trials recently carried out in the Firth of Clyde were, we learn, eminently satisfactory, and the fuel consumption was well within the guaranteed figure of 1.05 lb. of oil per shaft horse-power for all purposes. It may be remembered that the vessel is fitted with turbines driving the propellers direct, which, of course, are not quite so economical as a geared turbine installation of similar power would be. The speed attained on the trial was 19½ knots, and in the course of her passage from the Clyde to Southampton, a further twelve-hour consumption trial was run, during which time an average speed of over 19 knots was maintained, while the highest speed recorded was 20.8 knots. It may be fully expected that the reconditioned Empress of France will retain her reputation as the fastest liner in the Canadian service.

The Channel Tunnel.

THE present Government is being invited to give renewed consideration to the desirability of constructing a Channel tunnel, partly as a means of relieving unemployment and partly for the sake of international relationships. Mr. MacDonald is alive to the fact that many of the reports prepared on the scheme for previous Governments are now out of date, and has promised to receive a representative deputation on the subject some time after Whitsuntide. That deputation, it is learned, will be introduced by Sir William Bull, chairman of the House of Commons Channel Tunnel Committee. We understand that among Members of Parliament of all parties a very large majority—over 400 it is said—have expressed themselves as being in favour of carrying out the scheme. It is well known, of course, that no engineering difficulties of any moment stand in the way of the work, and that complete plans for it are now in existence. The political aspect of the matter has alone been responsible for the delay in beginning the tunnel.

A Novel Motor Launch.

Two interesting boats designed with motor propelled land wheels have just been delivered, says the *Journal of Commerce*, to a Scarborough owner by the Amphibious Motor Boat Company, of Liverpool. They are 19ft. long, 6ft. broad and 3ft. deep, and the propulsive power is furnished by a self-starting motor engine of the Ford type, which is designed to give a speed of 8 miles per hour, both on land and in the water, with a consumption of about one gallon of fuel per hour. The engine speed of 1500 revolutions is reduced to half speed at the propellers by a reduction gear. Two land wheels are provided amidships, each having a diameter of 4ft. They are constructed of $^{3}/_{16}$in. steel plates, with oak rims bolted to them. The oak is said to give better adhesion on the sand, and to assist the buoyancy of the craft, each of the wheels only weighing 1¼ cwt. The power is transmitted to these side wheels through worm gearing, which gives a speed of 8 miles per hour on land when on top gear and 3 miles when on bottom gear. Two stern steering wheels, made of thin steel plate, are fitted on either side of the propeller, and are controlled from the driving platform. When in the water these wheels act as rudders, and they are placed sufficiently far apart not to interfere with the flow of water from the propeller. On land the boats have a clearance of about 7in. from the ground. They are designed to carry twelve passengers, as well as the boatmen and the engineer. During the trials one of the boats was driven to the sea beach from a garage about a quarter of a mile distant, and after the trials the boat came straight out of the water, on to the beach, and travelled up an incline of about 1 in 7 to the place of disembarkation. The new boats, it is stated, are a distinct improvement upon the Sea Lion, the first amphibious boat which was built by the company for experimental purposes.

A Long Distance Wireless Telephony Test.

ON Sunday night, June 1st, an interesting and important wireless telephony experiment was carried out between the Marconi experimental station at Poldhu and the Amalgamated Wireless Company's experimental station at Vaucluse, Sydney. It has been reported that Mr. Marconi's beam system was used, but it appears that this statement is not wholly correct. The test seems, however, to have been quite successful, the words transmitted being perfectly audible. In an interview, Mr. Marconi is reported to have said that "there will be no distance in future over which we cannot telephone," but the important point is, of course, the amount of power required. It would be interesting to know exactly what system was used for last Sunday's test, and how many kilowatts were employed.

The Robert Blair Fellowships.

THE London County Council has now published particulars of the Robert Blair Fellowships in Applied Science and Technology, to which reference was made in the Journal for March 7th. These fellowships, of which two will be awarded each year, carry a grant of £450, and are therefore entitled to rank among the most attractive scholarships available to young engineers endowed with powers of observation and initiative. Applicants must be British subjects of at least twenty-one years of age, preference being given to students of engineering science, and to those who have completed a course of study in London institutions or have been identified with the London teaching service. In selecting candidates, the London County Council will have the advantage of the co-operation of a distinguished consultative committee on engineering, whose members at present are Sir Dugald Clerk, Sir John Snell, Sir Wilfred Stokes, Mr. C. P. Sparks, and Sir Charles Parsons. The successful candidates will be required to undertake an advanced course of study or research in the Dominions, the United States or other foreign countries, and at its conclusion to submit a report upon the work accomplished. The London County Council reserves the right to publish this report. The fellowships, it will be recalled, have been founded as an outcome of the war work undertaken by the Council in the training of munition workers and the manufacture of gauges. The sum of money accruing to the Council from that work is being expended in part in providing the grants.

University College Engineering Laboratories.

ON Wednesday afternoon an at-home was held at University College, University of London, Gower-street, to commemorate the reconstruction and re-equipment of the new buildings of the Engineering Department. The sum of money raised for this purpose amounts to approximately £53,000, and includes gifts of apparatus to the value of about £900. The London County Council has contributed £10,000, and a further £10,000 has been given by Viscount Cowdray, who has also promised a second sum of like amount when a total of £70,000 has been collected. In addition to these gifts contributions have been received from old students, prominent engineers and industrial firms. Sir Ernest Moir, Bart., is the treasurer of the fund, and he has also given generous personal help in supervising the building and reconstruction operations. Two new floors have been built over the old laboratories, which give a new research laboratory about 130ft. long by 50ft. wide on the first floor, while the top floor provides a well-lighted drawing-office with accommodation for about 100 students. The Charles Hawksley hydraulic laboratories, which were begun in 1920 and were built by excavating under the quadrangle, have now been completed, and are fully equipped with apparatus and an engineering workshop, towards the cost of which the family of the late Mr. Charles Hawksley has contributed £3000. The Ramsay Memorial Laboratory for Chemical Engineering is accommodated in a building in Gordon-street near the other chemical laboratories. This new department is in charge of Professor E. C. Williams, and when its scope has been finally determined, it is proposed to erect new buildings on the same site. The visitors were shown over the laboratories by Professors E. G. Coker and J. A. Fleming, and many instructive experiments were seen. Among the new testing machines we noted several by continental makers. It is to be regretted that British testing machines do not figure more prominently in a laboratory which has been largely equipped from a London County Council grant.

G

The British Empire Exhibition.

ENGINEERING EXHIBITS, No. VII.*

GENERAL ENGINEERING EXHIBITS.

DAVEY, PAXMAN AND CO., LIMITED.

AN outstanding example of one of the typical products of Davey, Paxman and Co., Limited, Colchester, is a 400-kilowatt steam-driven generating set which is used to supply power to the Exhibition. We show in the accompanying illustrations—Figs. 146 and 147—views of this very handsomely finished and quiet-running engine and its generator. The engine is of the tandem compound type fitted with the Paxman-Lenz positive valve gear, and the direct-current generator built by the Electric Construction Company, Limited, is mounted directly on the engine crank shaft, and is designed for an output of 300 to 400 kilowatts at 440 to 460 volts when running at a speed of from 130 to 150 revolutions per minute. The cylinders of the engine are 17¾in. and 29½in. in diameter with a stroke of 30in. It is shown running non-condensing, but the design is such as to admit of a condenser and air pump being added if desired. The cylinders and valve gear have been designed for initial steam pressures up to 180 lb. per square inch and a total steam temperature of 500 deg. Fah. In fact, the engine has been specially constructed to use highly superheated steam. From the illustration reproduced in Fig. 147 it will be seen that the engine bed-plate is of the girder type with a very large surface resting on the foundations. The fly-wheel, which is 9ft. 10in. in diameter and 14in. in width, has a total weight of 7¾ tons. Together with the rotating parts of the generator such a fly-wheel ensures a very small cyclic speed variation, and this same type of engine is quite well suited for alternating current work, as the desired limits imposed by the electrical conditions are easily met.

We have already remarked on the silence of the valve gear, which retains, we are informed, this characteristic even at the highest speed at which the engine can be run. Another feature of the design is the "Inertia" type of governor which is used. It is sensitive to the slightest variation in load, and is designed to keep any variation in speed within 1½ per cent. of the normal, even if half the load is suddenly removed. The non-hunting qualities of this governor, together with its sensibility and stability, give results which, the makers assure us, are comparable with the best turbine practice.

Referring to the resulting economy in steam consumption when the Paxman-Lenz positive valve gear is used, the makers claim that the results obtained are unequalled by any other steam engine at present on the market. The figures given in the accompanying table show the results of various tests which have been carried out on engines built by the firm.

Typical Results Obtained from Davey-Paxman Drop Valve Engines.

Duty of engine.	Pressure at engine stop valve.	Added super-heat.	Vacuum.	Steam per I.H.P. per hour.	
				Super-heated.	Satu-rated.
I.H.P.	lb.	Deg. F.	in.	lb.	lb.
366	170	150	26½	10.4	12.3
300	140	150	27	10.35	
600	170	100	25	10.91	
600	170	150	25	10.59	
570	150	175	27½	10.34	
425	170	150	Non-con.	13.45	
215	170	150	"	14.0	
537	168	175	24.25	10.38	
200	170	None	26	—	13.25
250	150	150	25	10.44	

The results on the first line of the table were taken from a 27½in. stroke engine within two days of starting it, and an overload of 33½ per cent. was easily carried. In the second line, figures obtained from a compound tandem engine are reproduced, the test results being taken after ten months' continuous working in a flour mill. The other examples are taken from electric lighting sets with the generator coupled direct to the engine or built on the crank shaft as illustrated. The examples cited would seem to show that even with moderate steam pressures the type of engine we are describing is very economical, and the economy is, moreover, maintained under actual service conditions. Engines are made either of the tandem type as shown in Figs. W34 and 35 or as coupled compound engines. The tandem units are made in sizes up to 1000 brake horse-power, and by arranging the cylinders in coupled tandem form units up to 2000 brake horse-power may be supplied.

Another prominent exhibit on the Davey-Paxman stand is a 9ft. 9in. diameter front end plate of the familiar Paxman "Economic" boiler. This plate is flanged for attachment to the shell, the tube holes are cut out and the flue and man-hole opening are flanged to receive the flues and cover. The type of boiler referred to consists, it will be remembered, of a cylindrical shell with two internal flues and a number of small smoke tubes running from end to end. A combustion chamber receives the products of combustion at the back of the boiler, the gases then pass through the small tubes to the smoke-box in front and back outside the boiler shell, entering the brick flue leading to the chimney. The advantage claimed for the brick combustion chamber at the back of the boiler is that when working the temperature is raised in it almost to a red heat, with the result that a more perfect combustion of the gases, reducing smoke to a minimum, is secured.

The Paxman "Economic" boiler is only half the length of a Lancashire boiler of corresponding capacity, and, according to tests made by Professor Sir Alex. W. B. Kennedy, an evaporation of 12.2 lb. of water from and at 212 deg. Fah. has been obtained. The boiler plate shown is for the 100 horse-power size, which has an overall length of boiler of 15ft. 6in. and a total heating surface of 2015 square feet.

The firm is also showing one of its 20 horse-power Colchester steam engines with compound cylinders of 9in. and 15in. diameter with a stroke of 16in. It is fitted with a 6ft. fly-wheel having a face 11in. in width. When supplied with steam at 140 lb. per square inch pressure and running at 135 revolutions per minute the engine is designed to develop 50 to 60 brake horse-power. It is simply constructed and is fitted with automatic expansion gear on the high-pressure cylinder, which

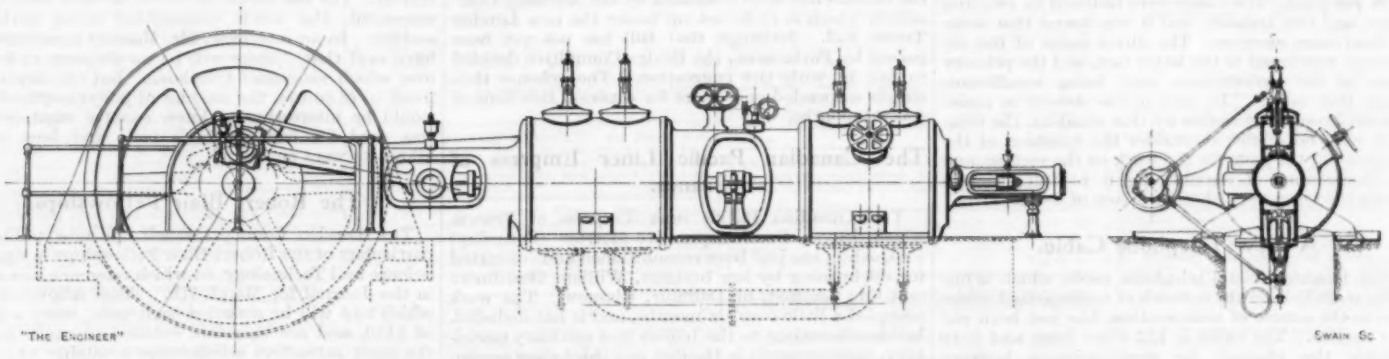


FIG. 146—400 K.W. TANDEM COMPOUND STEAM ENGINE—DAVEY, PAXMAN

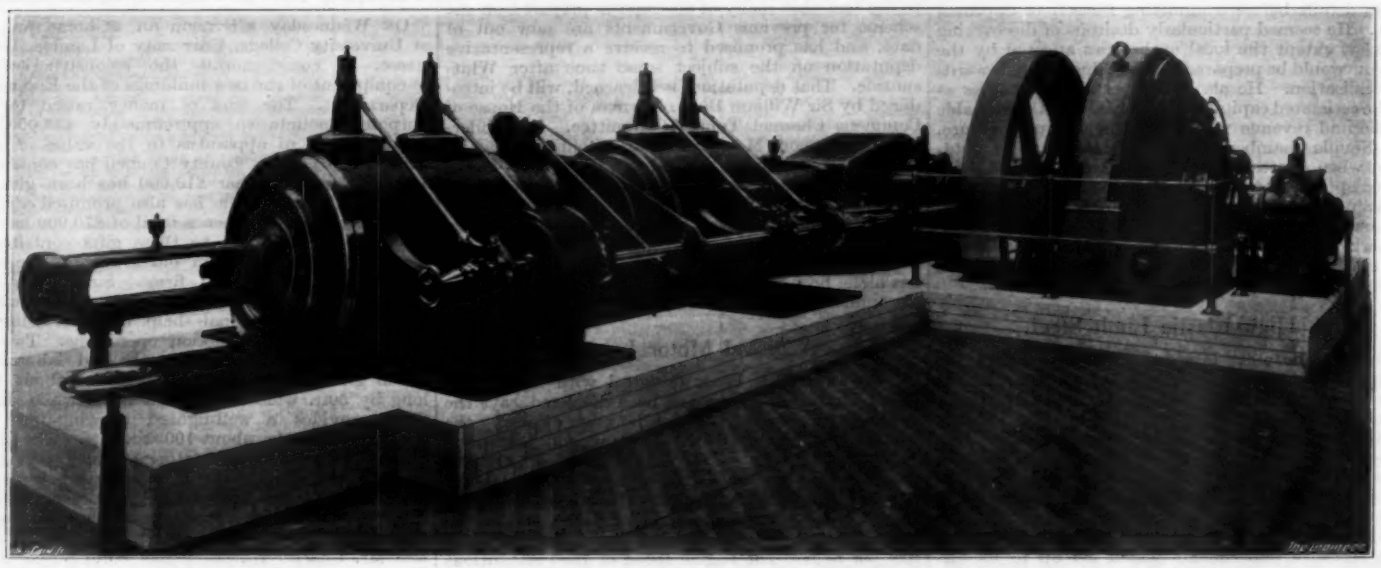


FIG. 147—400 K.W. STEAM ENGINE AND GENERATOR—DAVEY, PAXMAN AND ELECTRIC CONSTRUCTION COMPANY

* No. VI. appeared May 30th.

secures maximum economy when running under varying load.

The Paxman Locomotive Valve Gear Company, Limited, of Colchester, is also showing a model illustrating the application of the Paxman-Lenz locomotive cylinder. This model shows the valve boxes and operating gear for an inside-cylinder locomotive. Another model shows the patented valve box in section, so that the design of the valves and the internal parts may be inspected. Various other details illustrating the construction of the valves and the operating gear and their application to locomotive work are also shown.

SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIMITED.

Among the few machine tools at the Exhibition those shown by Armstrong, Whitworth and Co., Limited, Openshaw, Manchester, are conspicuous. We illustrate two of these machines in Figs. 148 and 149. Both are railway tools, the first being a lathe for turning carriage and wagon axles, and the second a lathe for turning the tires of carriage and wagon wheels after being mounted on their axles.

The axle lathe turns the journals and wheels seats at both ends simultaneously, roughing and finishing the work at one setting. The axle is held and driven at the mid point of its length, a procedure rendered possible by the fact that it is left black between the wheel seats. The chuck is of the firm's patented design. It has three jaws, which are closed down on the work by means of a system of levers and screws, and is claimed to hold the axle without backlash and without allowing it to spring or jar under a powerful drive and heavy cut. Each tool rest is provided at the front side with two separate roughing tools. Each of these tools consists of a stout mild steel bar serving as a holder, at the end of which there is mounted on a stud let into the bar vertically a circular cutter of tool steel. The cutter is in the form of a truncated cone with the larger diameter uppermost, and on the top face is slightly dished, this dishing and the angle of the cone determining between them the cutting angle of the tool. At first it was the firm's practice to secure the cutter tightly to the bar in order to prevent rotation. It was soon found, however, that with the tool loose on its stud—even so loose that it might be spun round with the fingers—there was no tendency for it to rotate under the combined action of the thrust from the work and of the feed. When the journal and wheel seat have been roughed out by means of these cutters a finishing cut is taken with a forming tool carried at the rear side of the tool rest. The journal is subsequently finished with a planishing roller mounted on the front portion of the rest. It is claimed that the use of a planishing process for this part of the work gives a result superior to grinding, in that it tends to harden and consolidate the surface. The machine can be used either for roughing or for roughing and finishing the axles completely. When roughing only it has been found possible, we are informed, to bring the work to within $^1/_{32}$in. of the finished size in fifteen minutes floor to floor, and under test conditions for maximum production in ten minutes. The machine is equipped with position and spring trips for the longitudinal feed which prevent the accidental over-running of the tools and with adjustable stops for the depth of cutting. It has a centre height of 15in. and will admit between centres work up to 9ft. 3in. long. Its overall length of bed is 14ft. 3in.

The wheel lathe—Fig. 149—has been specially designed for heavy service on hard tires. It is fitted with a patented form of chuck, so designed as to secure a firm grip of the wheels without springing them out of their normal relationship to the axle. By means of separate connecting links passed through the sprag holes the same principle can be applied to the chucking of disc wheels. The spindle noses are bored with a taper and a set of cone bushes is supplied to fit upon the journals of axles having outside bearings. For axles with inside journals plain centres are supplied. The driving shaft is placed along the front of the bed and transmits through a gear train on to an auxiliary shaft at each headstock, which auxiliary shaft is geared through a pinion with the face-plate. It is claimed that by arranging the main driving shaft as described instead of passing it through the centre of the bed it is made easily accessible and the reinforcement of the bed with box ribs can be made stronger. The tool holders are bolted to the top rest of the saddle and the tools themselves are either inserted in or bolted to the holders. For regrinding purposes the small pieces of high-speed steel are alone removed. For roughing cuts the tools are of circular form, as in the case of the axle lathe described above, while for finishing, forming tools of the nature of a blade are used. An interesting feature of the machine which, being on the far side, is not very clearly seen in our engraving, is an inclined rolling platform whereby the wheels can be rolled into and out of place from and to the workshop floor with little trouble or exertion. This platform can be adjusted in height by means of screws to suit different diameters of wheels. For the re-turning of wagon wheels the output, the makers inform us, is one pair in eighteen minutes from floor to floor, while under test conditions for maximum output the time can be reduced to fifteen minutes. The machine will turn wheels up to 4ft. diameter on the tread. The maximum distance between the face-plates is 8ft. 6in. and the overall length 23ft. 6in.

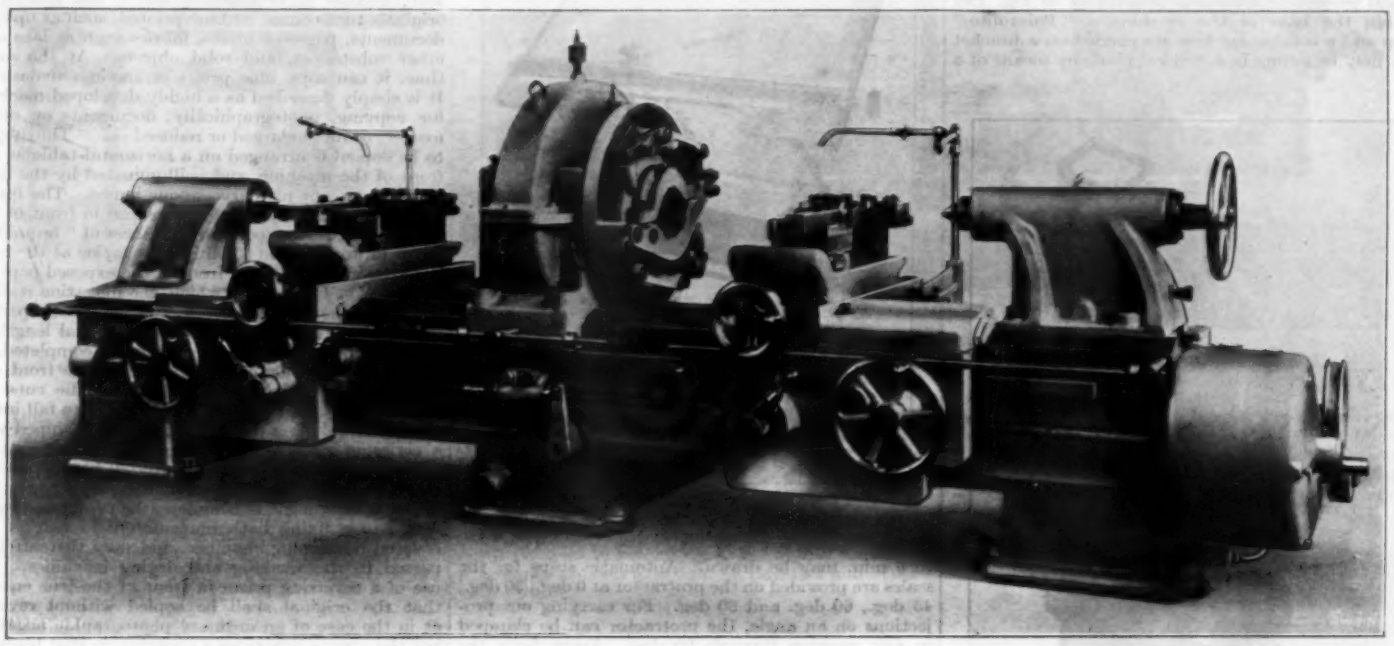


FIG. 148—RAILWAY AXLE LATHE—ARMSTRONG, WHITWORTH

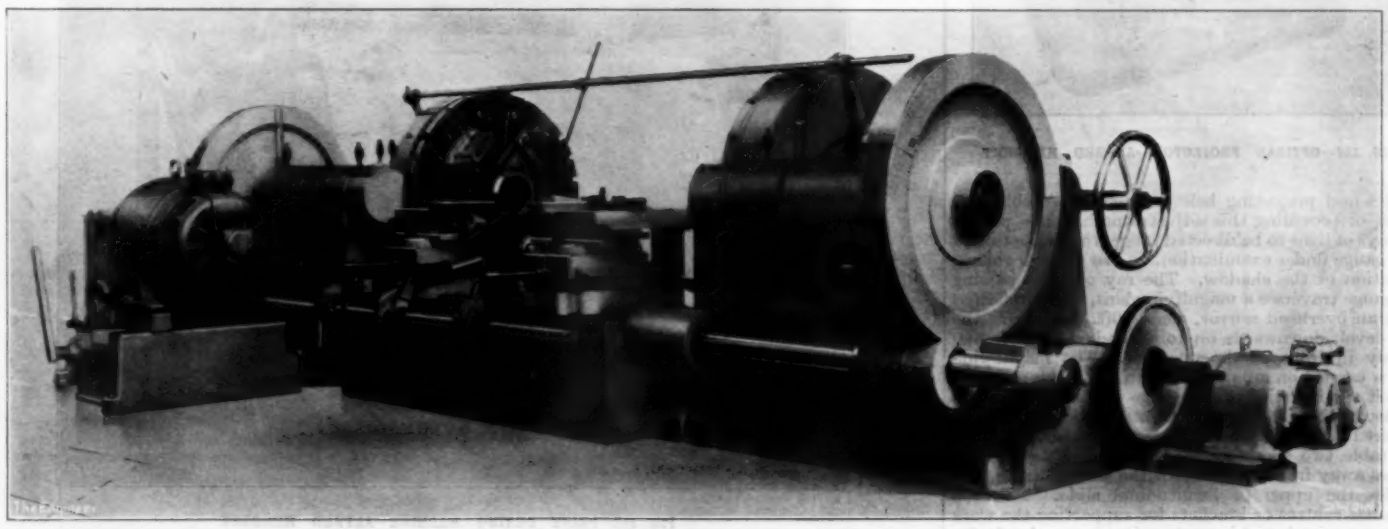


FIG. 149—RAILWAY WHEEL LATHE—ARMSTRONG, WHITWORTH

ALFRED HERBERT, LIMITED.

On the stand of Alfred Herbert, Limited, of Coventry, while there are, of course, no machine tools, there are several devices and appliances of interest to machine tool makers and to engineers generally. There is, for instance, the Wickman universal gauge-measuring machine, a full description of which was

given in our issue of March 9th, 1923. Although the machine at that date had barely emerged from the trial stage, we find that the example shown at Wembley differs in no essential principle, and only slightly in detail from that previously described. It is therefore sufficient to recall that this machine has been designed to provide at a reasonable cost a means for the verification of workshop gauges quickly and accurately, as a matter of routine, in the tool-room or elsewhere without the provision of laboratory conditions, such as an equable temperature, absence of vibration and high skill on the part of the operator. One of its most interesting mechanical features is the use of two pairs of hardened steel rollers, and three groups of hardened steel balls, in place of the usual machined guiding surfaces for supporting the main slide on the bed.

Another interesting machine for examining screw gauges, profile tools and other objects is the vertical optical projection apparatus, illustrated in Fig. 150. Within the base of the machine a "Pointolite" lamp and a condensing lens are carried on a bracket that may be swung in a vertical plane by means of a

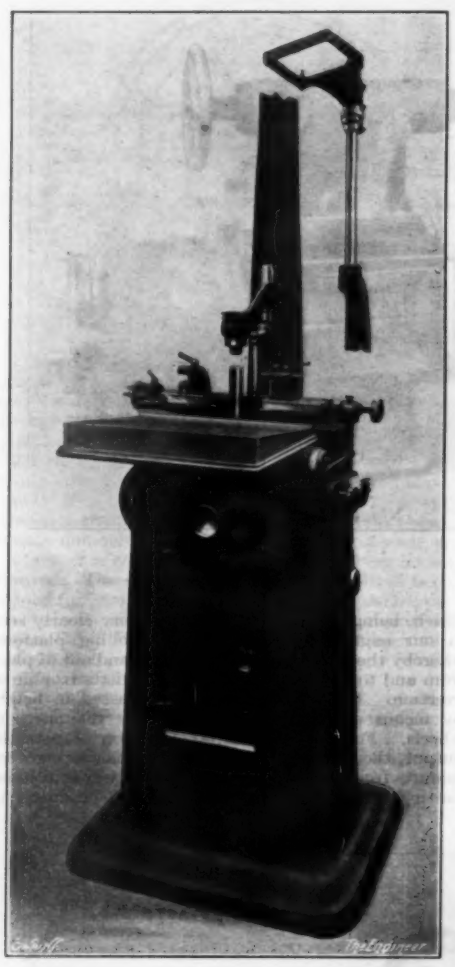


FIG. 150—OPTICAL PROJECTOR—ALFRED HERBERT

hand wheel projecting below the shadow table, the object of providing this adjustment being to permit the rays of light to be directed tangential to the thread on a gauge under examination, and so to secure sharp definition of the shadow. The ray of light passing the gauge traverses a magnifying lens, and is reflected from an overhead mirror, some 10ft. 6in. above the floor-level, downwards on to a shadow table immediately in front of the operator. The magnifying lens is carried on an arm that can be swung round to permit the insertion of the gauge in the holder. The shadow table is inclined to the horizontal at the angle required to secure accurate enlargement. Behind the table two slides are provided. The lower slide moves away from and towards the shadow table, and carries the upper or longitudinal slide. This top slide has centres or brackets for supporting the work to be examined, and is equipped with a spring buffer and a quick-return movement. In addition, it has a micrometer attachment to permit pitches or other dimensions to be measured. The device gives a magnification of 50 to 1. It admits, for inspection, work up to $4^{3}/_{16}$in. in diameter, and can measure a maximum pitch length of 2in.

Four appliances of interest to the drawing-office are exhibited on Messrs. Herbert's stand. The "Simplon" universal drafting machine, illustrated in Fig. 151, differs entirely from the familiar pantagraph device for the same purpose. Two drawing scales fixed at right angles to each other are mounted on a protractor head, which runs on ball bearing rollers on a horizontal steel track, extending the full width of the board. The track is divided into sixtenths of an inch, so that projections can be made without reference to a base line on the drawing. A wooden base, with an ebony straight edge, supports the track. Through this base there runs from end to end a steel roller provided with pinions which engage with two racks, one at each edge of the drawing board. By these means the ebony straight edge is caused to move with a truly parallel motion. The straight edge and all the parts attached to it are counter-balanced to facilitate the use of the device on an inclined board. The protractor is graduated in degrees up to 90 deg., and is equipped with a vernier whereby angles down

FIG. 151—DRAFTING MACHINE—ALFRED HERBERT

to 6 min. may be drawn. Automatic stops for the scales are provided on the protractor at 0 deg., 30 deg., 45 deg., 60 deg. and 90 deg. For carrying out projections on an angle, the protractor can be clamped in any position through 90 deg. Apart from the details of its construction, this drafting machine is noteworthy by virtue of the fact that no parts of it project beyond the edge of the board in any position. It is supplied either with or without the board, or with the board mounted on an adjustable stand.

A print-washing machine shown by the firm is capable of handling simultaneously anything up to sixty 10in. by 8in. prints. It consists of an open tank, within which is mounted on an axle a cage of perforated and corrugated metal, provided with a large door in its side and a turbine runner at one end. The washing water, drawn from a tap or a storage tank, after passing through the turbine wheel, flows through the cage and is discharged to waste through an overflow, which preserves a constant level of water within the cage. The cage is $27\frac{1}{2}$in. long by 15in. in diameter. The prints are subjected to a gentle but constant motion, and are, it is stated, completely washed in about ten minutes.

A complementary appliance to the washer is the print-drying machine illustrated in Fig. 152. This device consists of a power-driven drum heated either electrically or by gas, and enfolded by an endless fabric blanket, which runs over rollers and a tensioning bar. The prints are fed between the blanket and the drum at the foot of the machine, and after passing once round emerge dry and free from creases on to a perforated curved tray attached to the front of the framework. The drum has a diameter of 17in., and an effective width of 27in. or 28in. A motor of $^{1}/_{16}$ horse-power is sufficient to drive the machine.

The print-washing and drying machines just described are, by reason of their size, somewhat limited perhaps in their application to "blue prints" of the ordinary dimensions. They are, however, well adapted to handling the "bromide" prints produced by the "Lucigraph" photo-copying machine illustrated in Figs. 153 and 154. This appliance does not compete with the blue-printing machine on the score of cost of production, but it can deal with originals that cannot be blue-printed, such as opaque documents, pages of books, fabrics such as lace and other substances, and solid objects. At the same time, it can copy blue prints or tracings if desired. It is simply described as a highly developed machine for copying, photographically, documents or other matter, to full, enlarged or reduced size. The subject to be copied is arranged on a horizontal table at the front of the machine, and is illuminated by the light of two adjacent mercury vapour lamps. The image is caught by a reversing prism placed in front of the camera lens, and is focussed on a sheet of "bromide" paper unwound from a roll in a magazine at the rear. A screen immediately in front of the exposed paper—as shown in Fig. 154, in which the magazine is illustrated in the open position—can be set to permit prints of one-half or one-third the normal length of 24in. to be taken. When exposure is completed, as timed by a seconds clock attached to the front end of the camera, the operation of a handle cuts the exposed portion of the roll and allows it to fall into a covered developing dish. This dish is equipped with a series of paddles on three shafts, which can be rotated by means of a small external handle, and so cause the prints to move in the developing solution. When development is complete, the prints are transferred to a fixing bath immediately in rear of the covered developing chamber, and may thereafter be passed to the washing and drying machines. The use of a reversing prism in front of the lens ensures that the original shall be copied without reversal as in the case of an ordinary photographic negative, but the copy is otherwise a negative, in that black on the original appears as white on the copy, and *vice versâ*. The lens and prism can be lowered below the middle position in order to facilitate the taking of prints one-half or one-third the full length of 24in. On the side of the magazine are dials and handles for indicating the amount of sensitised paper exposed and wound off, for cutting it after exposure and for raising and lowering the screen in front of the paper. An automatic device is also provided on the magazine whereby the operation of unwinding a succession of whole, one-half or one-third lengths is greatly facilitated. The appliance can produce prints up to 18in. by 24in. in size, and can accommodate and photograph originals measuring up to 40in. by 53in. The magazine can hold a roll of bromide paper 18in. wide by 350ft. in length.

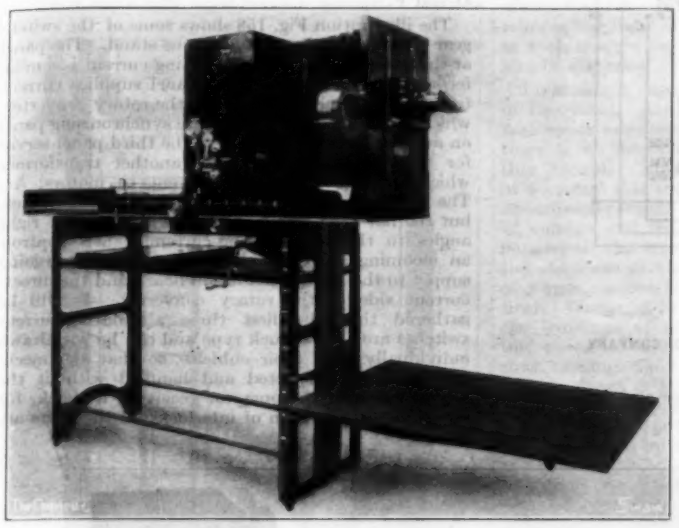
FIG. 152—PRINT DRYING MACHINE—ALFRED HERBERT

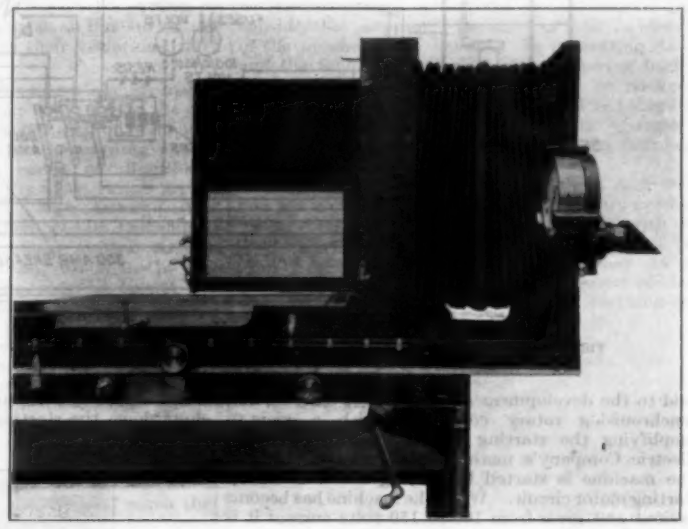
The "Atritor" equipment for pulverising, drying and firing coal is also exhibited by Messrs. Herbert. This pulverising machine was briefly described in our issue of August 5th, 1921, but at that time we were unable to illustrate its interior construction. We now

do so in Fig. 155. The raw coal, ¼in. in size and downwards, is delivered to the hopper of the machine, and is fed to the interior by a worm conveyor, the speed of which is adjustable to suit all outputs from large to small. The descending coal is caught by a current of cold air, travelling sufficiently quickly to propel it into the pulverising chamber, but not adequate to sustain heavy materials. Such materials, if present, fall outside the machine through a discharge. The portion of the chamber, where the pulverising action is continued. The finer particles of the fuel are picked up by the fan draught, and carried to a rejector. If they are sufficiently fine to pass this device, they are delivered to the furnace for combustion, but if not they are rejected and are returned for further reduction. A crane is provided on the casing to facilitate the rapid dismantling and re-assembly of the machine. If the fuel is of a very low grade and deficient in the coal much lower grades of fuel can be burnt than is otherwise possible.

OIL PALM FRUIT TREATMENT PLANT.

Through a misunderstanding, the oil palm fruit treatment plant described in our issue of May 23rd was stated to be shown by Manlove, Alliott and Co., Limited, of Nottingham, as part of an installation





FIGS. 153 AND 154—THE "LUCIGRAPH" PHOTO-COPYING MACHINE—ALFRED HERBERT

coal thus freed of metallic and other impurities, enters the pulverising chamber through ports, below which a supply of air at not less than 400 deg. Fah. also enters the chamber in order to dry the fuel during the pulverising process. The hot air supply is controlled by a butterfly valve. At any instant the coal in the machine does not exceed a few pounds in weight, so that the surface of the fuel exposed to the influence of the drying air is very great. The pulverising of the volatile matter, it can be rendered easily combustible by adding to it a minute quantity of paraffin. This paraffin during the pulverisation of the fuel is completely atomised. The machine is made in various sizes, having a pulverising capacity ranging from 500 lb. to 4000 lb. of coal per hour. It has found useful application in cement works for the supply of powdered coal to rotary kilns, but at the Exhibition it is shown applied to a dummy Babcock and Wilcox

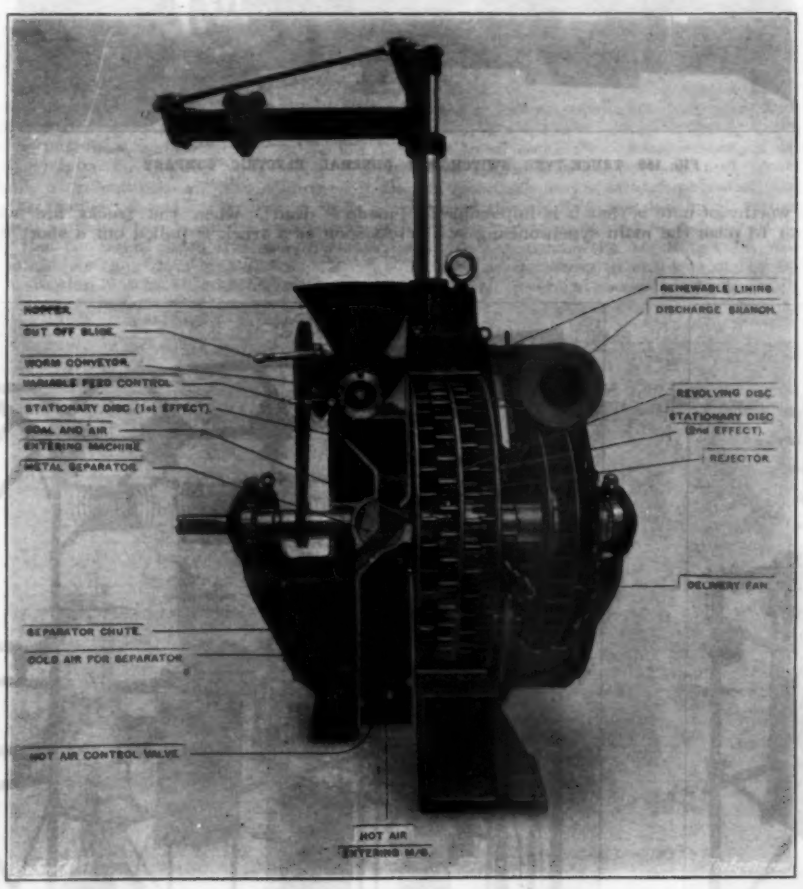


FIG. 155—THE "ATRITOR" COAL PULVERISING MACHINE—ALFRED HERBERT

coal is effected by the attriting action of a rotating steel disc carrying cast iron square-sectioned beaters or pegs arranged at various radii on both faces. Similar pegs are also fixed to the stationary walls of the chamber. The beaters create air currents of widely varying velocities, the scrubbing effect of which breaks the coal down into powder. As the coal becomes reduced in size, it is carried by the fan draught over the periphery of the rotating disc into the second boiler. The "Atritor" is self-contained in all respects, and, in particular, does not require magnetic separator screens nor storage bunkers for the powdered fuel. It is claimed that as the drying takes place within the machine itself, there is no loss of volatile matter, and that the device is quite dustless and noiseless in operation. An interesting feature in connection with it is that, as has been said above, by the addition of a very small quantity of paraffin to

manufactured by them for Nigerian Products, Limited. We are informed that the plant is the exhibit of Nigerian Products, Limited, and that it was made by Manlove, Alliott and Co., Limited, to designs prepared in collaboration with Nigerian Products, Limited.

ELECTRICAL ENGINEERING EXHIBITS.

THE GENERAL ELECTRIC COMPANY, LTD.

We were invited recently by the General Electric Company, of Witton, Birmingham, to inspect its mechanical and electrical exhibits. Some of the more important things the company is showing we have already described, but there are nevertheless other things which we have not so far mentioned and which are well worthy of attention. The company's pavilion has been designed to demonstrate the ability of the firm to undertake all work connected with the generation,

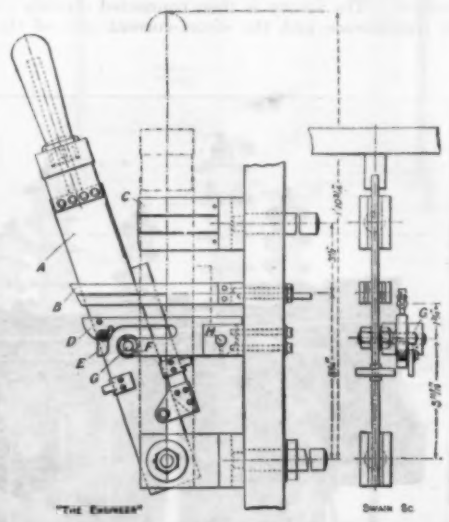


FIG. 156—ROTARY CONVERTER STARTING SWITCH—G.E.C.

distribution, and application of electricity in the factory, workshop, and in the home. An area of over 5000 square feet is covered by the pavilion, which for the most part is arranged in two storeys. Besides a model electric shop and other things of interest to engineers, there is much on the ground floor that appeals to the general public, such, for instance, as an electric kitchen and an illuminated rock garden. On the upper floor there is an elaborate sitting-room, a large hall for the display of lighting fittings, and a conference and cinema room, in which cinema films depict the manner in which the company's innumerable products are manufactured. Showcases on the walls contain lamps, thermionic valves, &c. The most important heavy engineering exhibit on the ground floor is a 5000-kilowatt turbo-generator, which has already been described in our issue of April 25th. Brief reference was made in that issue

to a rotary converter, which is to be seen in operation on the stand.

Within recent years considerable attention has been paid to the development of schemes for starting and synchronising rotary converters with a view to simplifying the starting process, and the General Electric Company's method may prove of interest. The machine is started by closing a switch in the starting motor circuit. When the machine has become excited and gives from 100 to 150 volts current it is switched on to the slip rings through reactances by pushing a main switch into a preliminary pair of contacts, and finally, when the switch is pushed home, the reactances are short-circuited and the starting motor, which, of course, is of the induction type, is cut out of circuit. Alternatively, the converter can, of course, be started on the direct-current side. The general principle of the starting switch will be understood from Fig. 156, whilst Fig. 157 shows the main connections of the machine. After the starting motor switch has been closed, and as soon as the direct-current voltmeter on the synchronising panel shows 100-150 volts, the main synchronising switch is moved to its first position. The blade A in Fig. 156 makes contact with the long synchronising contact B, and it will be seen from Fig. 157 that under these conditions the slip rings are connected to the transformer secondary through the choking coils which limit the current taken by the machine, but the current is sufficient to pull the rotary into synchronism. When the machine is in step the needle of the alternating-current voltmeter connected across the choking coils drops practically to zero and the main synchronising switch is then pushed into the second position C, when the reactances are short-circuited. The rotary is then connected directly to the transformer and the direct-current side of the machine can be connected to the direct-current bus-bars. When the main switch is pushed home an electrical interlock operates a tripping mechanism which opens the circuit breaker and automatically shuts down the starting motor.

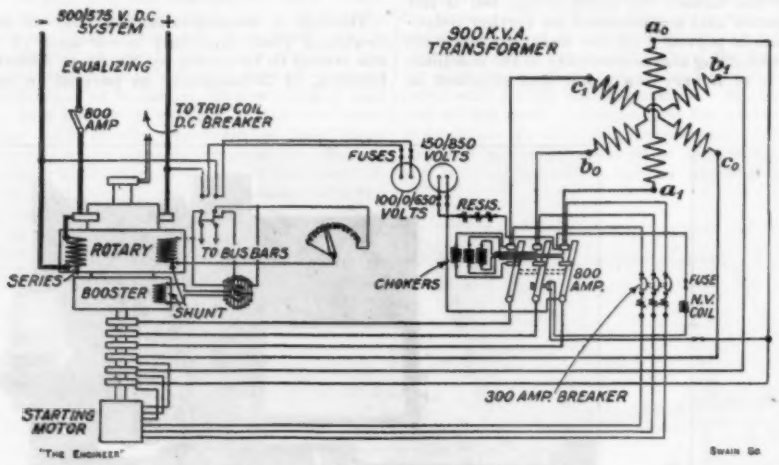


FIG. 157—CONNECTIONS FOR STARTING ROTARY CONVERTERS—GENERAL ELECTRIC COMPANY

into the second position without first placing it in the initial starting position. The device which prevents this happening consists mainly of a hinged member shown at D and F in Fig. 156, and a steel pin G which is fixed to the blade A. On closing the switch the hinged piece E makes the pin G butt against the part F and prevents further movement of the blade A. In order to make the blade fit into the second contact C the switch handle has to be pulled slightly forward, when the pin releases the slotted bar H, which drops and allows the pin G to pass into the slot between D and F.

The illustration Fig. 158 shows some of the switchgear which has been erected on the stand. The panel at the extreme left is an alternating-current incoming feeder panel, whilst the next panel supplies current to the transformer belonging to the rotary converter, which is provided with a separate synchronising panel on another part of the stand. The third panel serves for the control of current to another transformer which supplies alternating current to motors, &c. The next two panels are not at present in service, but the flat-back direct-current switchboard at right angles to these alternating-current panels controls an incoming supply at 440/220 volts, the outgoing supply to the main distribution board and the direct-current side of the rotary converter. It will be gathered that the first three alternating-current switches are of the truck type and can be withdrawn individually from their cubicles, so that the mechanism can be inspected and handled without the slightest risk of the operator receiving a shock, for owing to the provision of interlocks all the parts are

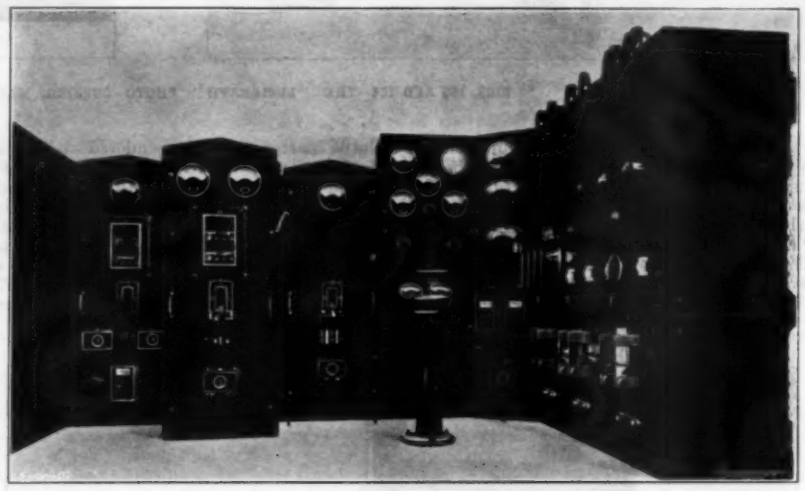


FIG. 158—TRUCK-TYPE SWITCHGEAR—GENERAL ELECTRIC COMPANY

A point worthy of note is that it is impossible for the operator to push the main synchronising switch made "dead" when the trucks are withdrawn. As soon as a truck is pulled out a short distance a

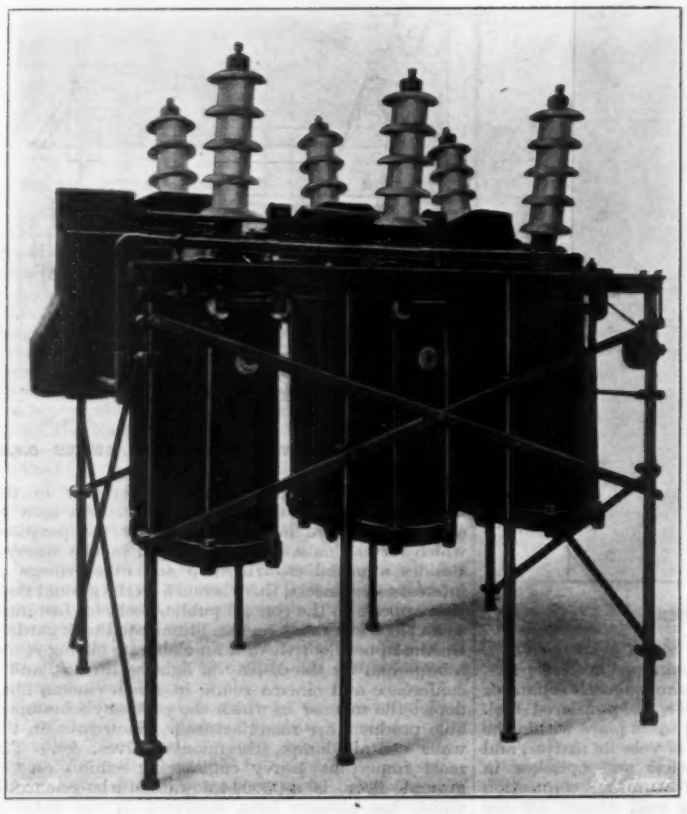


FIG. 159—45,000-VOLT OUT-DOOR CIRCUIT BREAKER—GENERAL ELECTRIC COMPANY

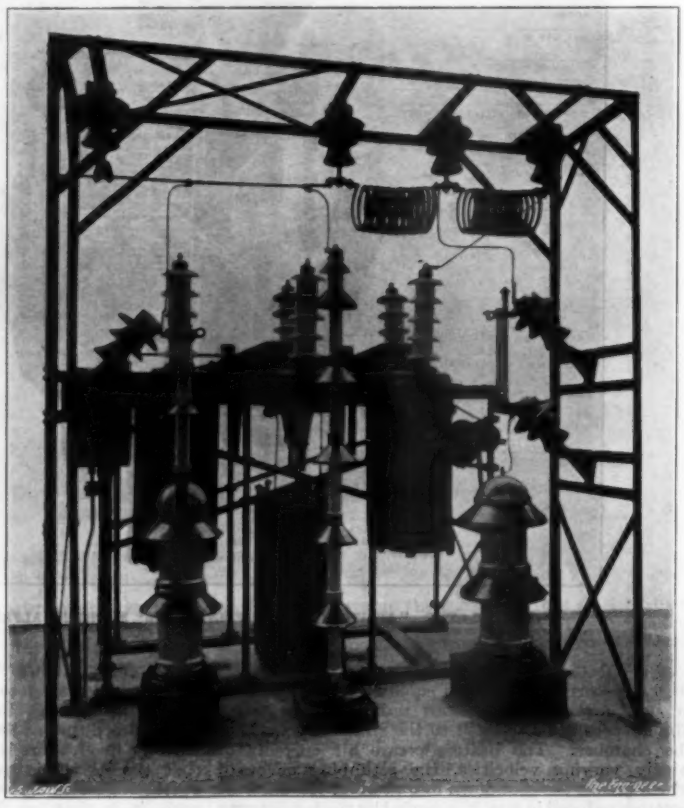


FIG. 160—ISENTHAL PROTECTIVE GEAR—GENERAL ELECTRIC COMPANY

shutter drops and completely encloses the bus-bars at the back of the cubicle. Various size switches can be accommodated in the cubicles, so that a uniform board can be made up, the individual boards dealing with the quantities of power required.

The 45,000-volt outdoor type circuit breaker shown in Fig. 159 is the same type of switch which the company has designed for the Victorian State Railways. Six of these switches have been supplied, each having a very large short-circuit breaking capacity. The switches are tripped by means of a solenoid and a very rapid break is secured. The new

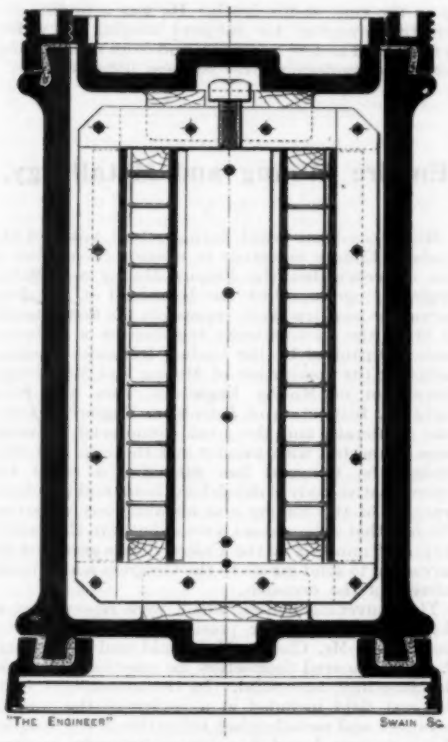


FIG. 161—INDUCTION COIL PROTECTIVE DEVICE—G.E.C.

Isenthal protective gear which the company is supplying for use on high-pressure systems, such as those for which this switch is designed, is shown in Fig. 160. The long slim member in the centre is a tension limiter. It consists of a number of spark gaps. On the right there is a unit, for dealing with high-frequency surges, which contains condensers constructed on new lines, whilst the unit on the left contains inductances for dealing with static charges. Choke coils or inductances are also connected in the line in the manner shown. Experience gained in Switzerland and elsewhere is said to have shown conclusively that the use of protective gear of this type greatly minimises the risk of breakdown.

Line protection is a broad and interesting subject, which has claimed the attention of many able electrical engineers. Static charges and surges should be guarded against, and for that reason various forms of protective gear have been introduced. Surges may be produced by resonance, switching operations, arcs and sparks and lightning effects, whilst static charges originate mainly from atmospheric effects. An insulated line suspended above the ground may assume a very high potential, and the practice of earthing the neutral point of the generators or transformers, is not considered, by those who have made a special study of the subject, to ensure that the static charge will be eliminated, especially when the earthing is done at a single point on the system. For relieving lines of static charges water jets have been used to a considerable extent, but they need attention, involve a certain amount of loss, and a supply of water must, of course, be available. Induction coils on iron cores—as shown in Fig. 161—however, do not need any attention and their efficiency is high. Moreover, they are claimed to overcome the troubles arising from arcing, which is one of the main causes of disturbances on alternating-current systems. The discharge to earth relieves the lines of static potential, but surges due to such charges or, rather, to their variations, must also be dispersed.

Lightning is capable of affecting a circuit, mainly in two ways. A direct stroke may attack the line and cause considerable damage, and unfortunately there is no method of effectively guarding against this trouble. The second cause of disturbance in a system due to lightning is when surges are set up indirectly from a discharge. Apart from questions of voltage and frequency there is one particularly dangerous characteristic of many surges, namely, the steepness of the wave front, which in the case of surges, caused by lightning, may be almost vertical. Waves of this type may, on passing through the windings of electrical plant, greatly increase the potential difference between adjacent turns, thus causing the insulation to break down, even if the voltage of the surge wave is lower than that of the line. It is quite impossible, the designers of this gear point out, to protect the system against the effects of these surges by the use of spark gaps which only come into operation when the disturbing voltage is higher than that of the line. An arrangement must be connected between the line and earth that is capable of flattening out the wave fronts, and of spreading the potential gradient so that the potential difference per turn will be kept below the value that will endanger the insulation. This result is attained by installing condensers at the entrance of the transmission line, and inductances are connected in series with the lines in front of the condensers—as shown in Fig. 160. The effect produced in the way of flattening out the potential gradients by a combination of capacities and self inductances was demonstrated in 1913 by E. Pfiffner, and also by M. Courvosier, who carried out a long series of experiments for Brown, Boveri and Cie.

Generators and transformers in electric-power stations are also exposed to surges of internal origin, and of low and medium frequency, which introduce danger because of their high amplitude. Sudden changes of load, the action of automatic cut-outs, short circuits, earths, &c., give rise at the point at which they occur, to waves with a more or less steep front. They travel along the line, and when they reach inductive windings or other parts where the electrical conditions change more or less abruptly, free oscillations are released, and sometimes result in resonance surges of high potential, and the straining of the windings and leading in terminals. These excess pressures should be taken care of by a non-inductive path, the resistance of which is such that the switching in and out of the path does not in itself produce excess pressures, and which also has sufficient heat capacity to absorb the energy represented by the discharge. A very suitable apparatus for this purpose is the well-known Giles valve. Underground cables must also be protected against surges of internal origin, and there again the Giles valve can be employed with considerable advantage. It is claimed that, provided these valves have a sufficient number of columns, the discharge resistance will automatically adjust itself to the particular conditions which prevail, and will bring about an almost instantaneous collapse of the surge.

On overhead lines oscillations are frequently set up as the result of earths. If an earth occurs on one phase, the other phases are raised to a higher potential with respect to earth, and the transformation from the normal to the new conditions gives rise to equalising oscillations and a consequent rise of potential. The tension limiter—shown in the centre of Fig. 160—will deal with this excess potential. Intermittent earths are most frequently the cause of dangerous surges in overhead systems. The danger is due to the frequency as well as the amplitude of these surges, especially as the latter may exceed the normal tension by a considerable amount. Because of the inductance of the overhead line between the generating station and the fault, the charging current flowing back to the source of energy may give rise to resonance surges of high amplitude. The intermittent character of the phenomena is due to the static charges on the line, arising at the moment when the first earth is broken.

The resulting surges rapidly attain a high value and the oscillatory discharge due to the arc produces waves of great amplitude. Spark gaps with low discharge resistance offer a certain amount of protection against this trouble, but as they do not remove the cause of the trouble they are not efficient. It is easy to understand the effect of earthing coils

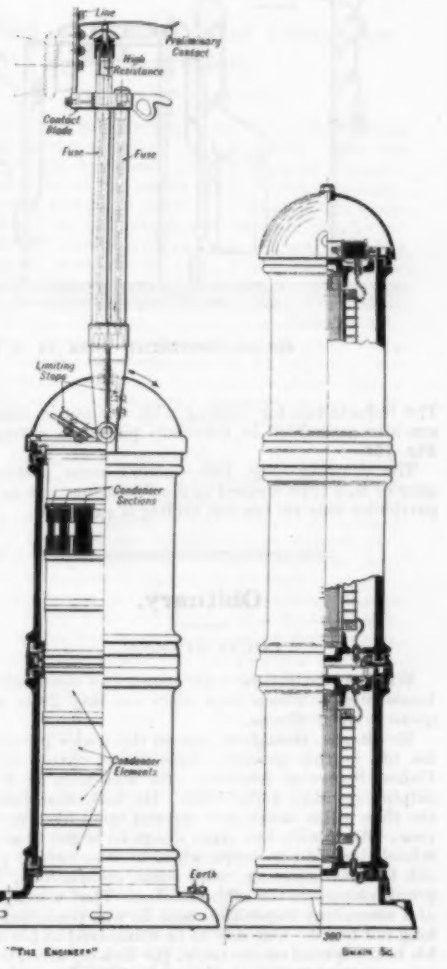


FIG. 163 FIG. 164

FIG. 162—PARTS OF CONDENSER UNIT—GENERAL ELECTRIC COMPANY

when used for dispersing the static charges and the intermittent earths which they produce. The apparatus has a moderate ohmic resistance, and on account of the magnetic saturation its self induction decreases when the discharge current increases, and this reduces the duration of the discharge and avoids repeated arcing. The value of the gear from a protective point of view depends on the number and the capacity of the coils which are distributed over the system.

The condensers which are now employed in connection with this protective gear are constructed on new lines. The main thing to be aimed at in the manufacture of condensers is to select a suitable insulating material. In the old type of Moscicki condensers glass was used, and for moderate pressures it proved quite satisfactory; its chief disadvantages being its lack of elasticity and the presence of internal stresses. Mica has excellent dielectric qualities, but it can only be obtained in sheets of small dimensions, and it is difficult to obtain sheets of the same thickness. Air pockets are very often present, and they cause considerable local losses and premature rupture. The dielectric material now used in the condensers is known as "Cellon," which is a substance of very great homogeneity. It is completely free from moisture, and it has a great resistance and high specific capacity. This material, which is transparent, can be obtained in any desired size and thickness. Moreover, the dielectric losses are negligible, and its resistance to puncture is

about 20 to 30 per cent. greater than that of the best quality mica.

It is extremely important that the metal coating in a condenser should adhere closely to the dielectric. In this new condenser the metallic coatings are deposited on the dielectric so that they cannot be detached. It is quite impossible, the makers contend, to obtain similar results by any other process of manufacture. The edge-discharges which are the chief causes of rapid deterioration are completely suppressed, and the same applies to the internal discharges. For high-tension work these condensers are made up in a number of elements—as shown in Fig. 162—and they are placed together and connected in series, each element being enclosed in a Bakelite tube, impregnated in vacuum and under pressure. These cartridges are mounted between metal caps and are placed on top of one another in substantial porcelain cylinders—as shown in Fig. 163. By assembling the elements in series in this manner it is possible to deal with any voltage.

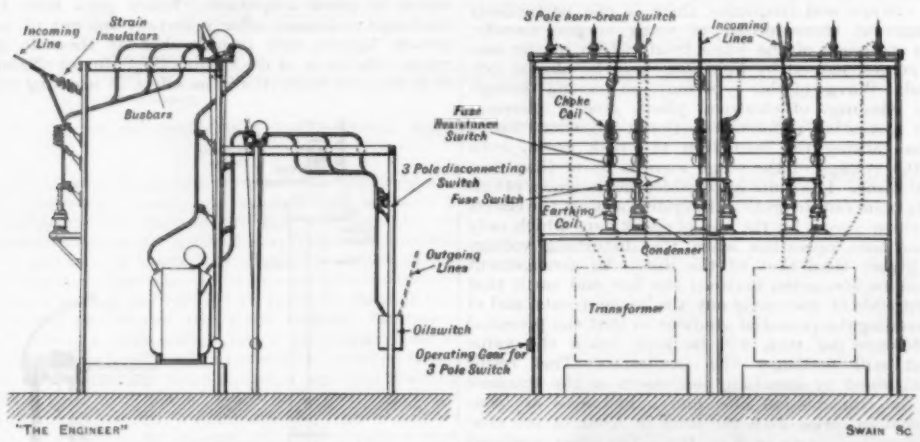


FIG. 165—PROTECTIVE GEAR IN A SUB-STATION—GENERAL ELECTRIC COMPANY

The inductances for dealing with the static charges are also assembled in porcelain pillars as shown in Fig. 164.

The drawing—Fig. 165—shows some protective gear of this type erected in a sub-station, but in this particular case no tension limiter is provided.

Obituary.

LOUIS STERNE.

WE have to record with regret the death of Mr. Louis Sterne, which took place on May 29th, after quite a short illness.

Mr. Sterne, though he passed the major portion of his life in this country, remained a citizen of the United States of America. He was born in Philadelphia on May 15th, 1835. He had, therefore, at the time of his death just entered upon his ninetieth year. When only five years of age he began to attend school, but had to leave when he was twelve years old for participating, with some companions, in a prank played on the schoolmaster. That worthy was of a somnolent disposition, and he was possessed of a long red beard. One day as he slumbered at his desk, his beard spread on the table, the idea occurred to the youngsters to fasten the beard to the table and then set off crackers under his chair. The joke succeeded only too well. The pedagogue jumped up in a fright, and, apparently, dislocated his jaw. All those who had taken part in the assault were suspended from school for six months. Young Sterne's studies were continued under the guidance of a tutor—for exactly how long we do not know, but not for a great length of time. In those days boys were put to work early, and it was quite as a young lad that Sterne began a working career which was destined to be of astonishing variety.

He was first employed in roughing out the blocks of wood for a carver of figureheads and statues for cigar shops. He soon tired of that, and having been promised lessons in drawing and work in a candlestick factory, left the wood carver's for the new employment. Instead of being taught drawing or the art of metal work, however, he was, being strong for his age, put to wheeling barrow-loads of goods and delivering them on to steamers. Annoyed at being deceived, the youth conceived the idea of dropping a barrow-load of goods into the water, so as to obtain his dismissal. He was next employed for about a year with a silversmith, and thereafter for a time in a brassfoundry, where his occupation was at first to act as a labourer working a foot lathe, for there was no motive power in the works. Later, he was "promoted"—to use his own word—to carrying brass fittings to different customers, and one day he was sent with a load—which he slung round his neck—to the Baldwin Locomotive Works, a tramp of about two miles. Having deposited his burden, he looked into the shop, and observed that all the machinery was being operated by steam power. Having himself acted the part of a prime mover, an establishment in which human effort was not called upon to make machines turn round appealed to him so strongly that he immediately went to Mr. Baldwin's office and asked for employment. He was engaged at a salary of 2 dollars a week, and made an agreement to remain for three years, with an advance of a dollar a week each year.

Sterne's connection with the Baldwin Works appears to have been entirely happy. Mr. Baldwin interested himself greatly in the boy, and evidently reposed considerable trust in him. Early in 1849, that is to say, when he was only fourteen, young Sterne was placed in charge of a small workshop on a line of railway which had been opened to develop a coal district near Tamagua, in Pennsylvania. He was there about a year. Subsequently, he was asked by Mr. Baldwin to take a locomotive to a new line of railway that had just been opened in Ohio, many miles from his home, from which he had never been away before. His work done, the spirit of adventure within him became too strong to admit of his return home. So he journeyed still further to Louisville in Kentucky and got work in a repair shop for river steamers. Then he went back to New York, where he studied engineering for a year, and again worked in the Baldwin shops, being there when the completion of the firm's fiftieth locomotive was celebrated. After short spells of work in Cincinnati and Texas, he was engaged in making a railway between Richmond and Houston, and in other railway work. While thus occupied, he made his first invention—the fitting of a hickory wood spring for propelling the shuttle of a loom to and fro.

From 1859 to 1861 young Sterne was engaged in the business his father had carried on, at first in Philadelphia and then in New York, where he joined the 7th Regiment of the New York State Militia, which on the outbreak of Civil War in April, 1861, was at once mobilised. Of his war experiences it is unnecessary to write. It will suffice to say that as the result of a wound received at Gettysburg his health was impaired, and he was advised to go abroad. He was appointed by President Lincoln a secret service agent or commissioner for the Baltic Coasts, his duty being to prevent the equipment of blockade runners, a post which he held till the end of the war.

Sterne came to England in 1865, intending to pay only a short visit of a few weeks, but the assassination of President Lincoln, who had been about to give him fresh employment in America, brought about a change of plans, and for the remainder of his life his domicile was in this country.

At first he was engaged through the introduction of Mr. (afterwards Sir) Daniel Gooch, as one of the staff looking after the paying out of the first Atlantic cable from on board the Great Eastern. On his return he was encouraged by Mr. Gooch and other railway engineers to develop his invention of railway buffers, draw and bearing springs, which was taken out in 1865. For this purpose he entered into partnership with a Mr. Townsend, which continued till 1873. He was then approached by Mr. W. S. Thomson with the invitation to become his partner to undertake the conduct of a similar business and works, known as the Crown Iron Works, Glasgow. The two firms were amalgamated under the title of Thomson, Sterne and Co., Limited, which continued as such till 1882, when on the retiral of Mr. Thomson the name was altered to L. Sterne and Co., Limited. In 1880 he started to manufacture gas engines at a separate works at Hollinwood, in Lancashire. The gas engine which had been developed in collaboration with Mr. (now Sir) Dugald Clerk was of the type having an impulse each revolution. An action for infringement having been successfully brought against the firm by Herr Otto, manufacture was stopped very shortly after it had been begun, and the Hollinwood works were disposed of.

After this setback, Mr. Sterne determined to take up the manufacture of refrigerating machinery, then in its infancy in this country. As the result of an extended tour of inspection, he chose the de la Vergne system of ammonia compression, and at once commenced manufacturing the machinery at the Glasgow works. The experiment was a success, and the two businesses—springs and refrigerating machinery—were carried on concurrently. In addition, Mr. Sterne purchased in 1876 the emery wheel making business of Wm. Warne and Co., and commenced to make, not only the wheels, but the grinding machines as well.

Mr. Sterne took an active interest in the business up to the time of his death. He was a prolific and versatile inventor, his subjects ranging as widely as from fluid meters to pianos, and from non-skidding devices to rendering silver surfaces untarnishable.

Empire Mining and Metallurgy.

No. I.

MUCH has been heard during recent years of the needs of Empire industries in relation to supplies of raw materials, but the Empire Mining and Metallurgical Congress, which has been held at Wembley during the past few days, represents the first attempt to bring the various units together on a technical basis. Organised by the leading technical societies, including the Institution of Mining and Metallurgy, Institution of Mining Engineers, Iron and Steel Institute, Institution of Petroleum Engineers, Institute of Metals, and the great commercial organisations connected with mining and the iron and steel trades—the Congress has attracted a small but representative body of delegates of home and Dominion branches of the mining and metalliferous industries. The fact that so important a contributor to the world's output of minerals as the United States accepted the invitation to send guests to the Congress added to the interest of the occasion.

The convening bodies, which were represented at the Congress by their presidents and the general secretaries—Mr. Charles McDermid and Mr. George C. Lloyd—spared themselves no exertions to make the meetings successful. In the attempt to cover the vast field included in a review of the mineral resources and metallurgical industries of the Empire, the organisers found it necessary to make arrangements for the presentation and discussion of nearly fifty papers. These contributions were divided into four groups—Mining, Petroleum, Iron and Steel Metallurgy, and Non-ferrous Metals—and by concurrent meetings of the sections it has been found possible to deal, at least in a cursory manner, with a vast number of topics. The decision to take the papers as read was wise, and indeed by no other means could time for discussion have been found. The papers, which include some notable contributions by recognised authorities on the subjects treated, can be studied at leisure.

The Presidents of the various sections are Sir John Cadman, Mr. H. M. Morgan, Mr. Herbert Barringer, Sir William Ellis, and Professor Thomas Turner.

Lord Long, the President of the Congress, in an interesting inaugural address, reviewed the present position and the outlook in respect to Empire sources of supply of raw material. He said that during his tenure of office as Secretary of State for the Colonies a Committee made exhaustive inquiries into Empire resources, including minerals. It was then shown that the mineral wealth of Great Britain and the Overseas Dominions was greater than had been generally believed. Nature had indeed been prodigal in her gifts of minerals to the various lands which constituted the British Empire. From the very beginning of the era of coal exploitation on a large scale, Great Britain had been a leader among producing nations. First place was now held by the United States, but the British output last year, 276,000,000 tons, was only inferior to that of America. Apart from the immediate by-product coke, coal was the foundation of a chain of industries. Attention was now being given to the evolution of a successful system of low-temperature carbonisation and the recovery of by-products additional to those now obtained. One happy sequel of the many processes of carbonisation would be the practical elimination of the smoke evil. Coal was now being mined in the Dominions in increasing quantities. The output of Canada last year was 17,000,000 short tons, and production was increasing in New South Wales and Queensland. In the case of oil the proportion of world supplies within the confines of the Empire was small. India, including Burma, produced last year about 1,000,000 tons; Sarawak, 560,000 tons; and Trinidad, 430,000 tons. Oil deposits in Great Britain had been proved, but were scarcely of commercial importance. There was, however, a very great potential source of oil within the Empire in shale deposits. Long before any real shortage of oil was felt, the vast deposits of shale, with which the Empire was richly endowed, would have been drawn upon to provide the fuel essential to industry. Apart from the Scottish shales, extensive deposits had been located in Norfolk, Dorset and elsewhere in England. Shale deposits of importance also existed in different parts of Canada, and much attention was now being given to the question

of shale exploitation in Tasmania. Another potential source of oil supply was to be found in torbanite, a substance similar to shale, but containing, it was claimed, a much larger proportion of the higher grade oils. New South Wales contained the richest torbanite deposit yet discovered; but important deposits existed in other parts of Australia, in South Africa, in Nova Scotia, Canada, and even in Great Britain. The improvements now being made in retorting suggested an important future for these resources.

IRON AND TIN.

The existence of native iron-bearing deposits in conjunction with coal had constituted one of the greatest factors in the industrial prosperity of the British Isles. In recent years the competition of richer or cheaper foreign ores had seriously affected the home industry, but in 1922 the quantity of iron ore and ironstone raised amounted to nearly 7,000,000 tons. Iron ore deposits of a remarkable character existed in Australasia, though it was only within recent years that endeavours had been made to turn them to commercial use. In the various States of Australia actual iron reserves had been estimated to amount to over 344,000,000 tons, while probable and possible reserves were estimated as being not far short of 600,000,000 tons. Extensive deposits of iron ore existed also in many parts of India, and in the Malay States, in Ceylon and Hong Kong. In Africa iron ore was found, not only in the Union, but in Northern and Southern Rhodesia, Swaziland, and in East and South-West Africa. Canada possessed large resources of iron ore, the quantity available being estimated at about 300,000,000 tons. Newfoundland, the oldest Dominion, possessed deposits of almost every known variety of iron ore; indeed, two of the largest mines in the world were situated on Bell Island. The reserves of the Bell Island deposits had been estimated at from 3,250,000,000 to 3,635,000,000 tons.

In the production of tin, Great Britain now occupied a minor place, but that was not true of the Empire. Although exact figures of last year's output were not available, it was probably in excess of the 129,000 tons recorded for 1922. The Federated Malay States, which not very many years ago contributed 40 per cent. of the world output, provided 35,300 tons last year, Northern Nigeria 5000 tons, and Australia 2500 tons. The Nigerian output, which had been restricted owing to price considerations, should now increase. It is satisfactory to learn that a new lease of life had been given to the Cornish tin industry. It has been found that various properties denuded of their payable copper ores contained good tin-bearing lodes at greater depth, and at the same time considerable areas of virgin ground had been found to the east of the existing workings. If, as was now thought, a substantially higher ratio of extraction could be obtained in the future, Cornish tin-mining should find its feet once more, a result much to be desired, for this long-established industry had been a profitable training ground for British metal miners and engineers, who had gone forth into all parts of the Empire.

COPPER AND NICKEL.

The world output of copper in 1923 was as high as 1,350,000 tons, but to this Canada contributed only 43,160 tons and Australia 18,200 tons. Recent developments at Port Kemble should improve the position in Australia in the near future. For some years before the war the zinc production of the world was fairly steady, the leading producers being the United States, Germany and New South Wales, from which countries 70 per cent. of the total output was obtained. In 1912 and 1913 New South Wales exported each year over 500,000 tons, whereas last year the Australian production was only 35,000 tons. Against this decline could be set the fact that the National Smelting Company had a large interest in the Burma Corporation, which was regarded as a potential producer of zinc on a very large scale.

Empire resources in nickel were on a more satisfactory basis. Canada, of course, produced an overwhelming proportion of this metal, and in the latter part of the war period the Dominion's contribution was 87 per cent. of the total output of the world. Last year Canada contributed 69 per cent. and New Caledonia 25 per cent. of the world's total. In Canada numerous deposits of nickel ore were known, but only the nickeliferous pyrrhotite deposits of Ontario had been worked so far. The deposits of the Sudbury region on the north side of Lake Huron were the largest and richest in the world. The ores, as mined, contained an average of 3.09 per cent. nickel and 2.12 per cent. copper. A conservative estimate of the proved ore in 1916, published by the Ontario Nickel Commission, placed the total at 70,000,000 tons, with a further 80,000,000 tons probable. Much importance attached to the discoveries of manganese deposits in various parts of the Empire during recent years. The Sinai Peninsula, the Port Augusta district of South Australia, Dagwin on the Gold Coast were among the new manganese mining areas, and the disorganisation of the Russian industry and the handicap under which the Brazilian industry was labouring presented an exceptionally favourable opportunity for the development of the manganese ore deposits of the British Empire. The output of lead from Empire sources had declined in the post-war period. In Great Britain the lead-mining industry was practically dead, but Canada had increased her production, and Rhodesia and India were two other sources of supply. In the production of chrome ore, Rhodesia led the world with an output last year of 100,000 tons. There was reason, too, for believing that the Province of Quebec (Canada) contained one of the largest known deposits of chromite, though not of high-grade ore. Of still another valuable alloy used in the manufacture of steel—molybdenum—the Empire possessed important supplies, Australia and Canada being among the world's greatest potential producers, although at present the United States occupied first place. The bulk of the world's supply of arsenic was derived from Empire sources, Canada being the principal producer. At one period, India, including Burma, took the lead in output of tungsten ores, but the Malay States, Australia and Great Britain all contributed.

Dealing with the outlook for new sources of supply, Lord Long said that in Rhodesia important schemes were approaching completion for the exploitation of copper and of silver-lead-zinc ores. India could show encouraging copper developments in the Chota Nagpur district. In Australia, though the known mining fields seemed to have passed their zenith, there was the immense Northern Territory that had scarcely been scratched. Empire mineral resources were on an enormous scale.

The afternoon of the opening day of the Congress, June 2nd, was devoted to an inspection of the mineral exhibits of the Dominions and India, the exhibit of the coal mining industry and model colliery, and the joint exhibit of the non-ferrous metal trades at Wembley. In the evening an interesting programme was arranged in connection with the visit to and reception at the Imperial College of Science and Technology.

The groups of papers dealt with on the second day of the Congress (Wednesday) included an account of researches on safety problems in mining, works problems, and methods of fuel economy in the iron and steel industry, coke oven practice in various countries, and modern British blast-furnaces. In the non-ferrous metals section technical interest turned on the account given of the development for industrial requirements of the light alloys of aluminium.

IRON AND STEEL PRACTICE.

Modern British blast-furnace practice has been a subject of controversy for some years, and Mr. Fred Clements' account of what is being done to effect improvements was opportune. His paper is mainly a description of the latest types of blast-furnace now in operation in Great Britain, which it was thought might be of interest to the delegates of an Empire Congress. The furnaces selected as typical of present practice are in operation at Carnforth, Port Clarence, Ebbw Vale, and Parkgate, and have been designed for working under dissimilar metallurgical conditions. Apart from good furnace lines, which Mr. Clements insisted were of the first importance, the main factors influencing design to which reference was made were the character of the ores and the nature of the fuel available. Height and diameter of stack, it was shown, influenced cubic capacity, but the diameter of the bosh was the deciding dimension as to the capacity of the furnace. Other points emphasised by Mr. Clements were regularity of materials charged into the furnace, good distribution, a supply of blast well over the maximum demand, and capable of easy regulation, and sufficient stove capacity to keep blast temperature up to the desired level without wide fluctuations. Examined in the light of these requirements, Mr. Clements criticised some of the details of the types selected as representing the best British practice, all of which were, he said, giving good service, but a study of which suggested that further developments should be made at an early date.

In a contribution on works problems and methods of achieving fuel economy in the iron and steel industry, Sir Robert Hadfield said that the application of principles to certain branches of fuel utilisation had followed empirical lines, a fact due mainly to the complexity of the problem. The paper, which covers a very wide field, has for one of its objects the determination how far rapid approximate methods can be used in controlling fuel utilisation. The author expressed his belief that in heat treatment and reheating furnaces there are great possibilities for improvement in fuel economy. Opinions are invited as to the relative merits of the gas-fired and solid fuel furnaces, having regard to the quality of gas required for steel heating. The more general application of the recuperator is advocated and a plea advanced for the use of improved refractory and metallic materials of construction for furnace chambers. Steel capable of withstanding the higher temperatures now employed is, the author indicated, now available through the work of a group of French metallurgists. In connection with heat losses it is pointed out that the greater proportion of the radiation loss takes place from the body of the furnace and can only be reduced at the cost of the life of the furnace and the refractory materials. The modern development of improving flame conditions by injection methods to increase the rate of melting and the extent to which, from the standpoint of fuel economy, improvement in chamber conditions may aid in a solution of this problem in open-hearth plant, are discussed.

The comparative survey of coke oven practice in various countries, which was made by Mr. G. A. Hebden, includes an account of the methods employed in Great Britain, the Continent of Europe, the Dominions and America. In European practice, the author says, the ovens being in most instances adjacent to the colliery, the bulk of the coal is taken in the form of raw coking slack from the pit head screens direct to the washery. In the United States and the Dominions practice varies from using all the coking slack to the running of a complete colliery, so that the whole of the coal drawn is prepared for use in the ovens. Washing and sizing and, if necessary, crushing is the custom in Europe and elsewhere even more attention is perhaps given to what is regarded as vital operations in the working of a coke oven plant. It is not the general practice to mix coal in Europe, but in the United States and the Dominions that practice is regarded as all-important. In carbonising methods the main differences between American and continental and British practice are in the adoption for American plants of the exclusive use of silica material for the ovens, with consequent higher temperatures and shorter coking period and the general use of large ovens.

Effect of Deep Water Quays on Navigation.

By ERNEST LATHAM.

DURING the last twenty years—though marking time during the period of the Great War—there has been a peculiar but steady development of an industrial character on the banks of the Thames Estuary.

The more ambitious schemes of constructing deep-water quays as individual and separate enterprises have been gradually scrapped one by one, including the original proposals at Long Reach, the "ocean wharves" scheme, and the works proposed and actually commenced at Thames Haven in 1908. It is true that the Port of London Authority themselves have recently constructed a deep-water cargo jetty of considerable dimensions at Tilbury, and that proposals are even now afoot which include the revival of the old idea of combining a deep-water quay with land development in the neighbourhood of Grays and West Thurrock.

There does not exist in the Thames Estuary to-day any quay accommodation in the open river designed to receive ships of large tonnage carrying passengers and general merchandise. Such ships at present invariably berth at the docks, though occasionally, as at Tilbury, embarking or disembarking their passengers by means of tenders in the open river.

The projects for an Essex-Kent Railway tunnel between Tilbury and Gravesend and a floating landing stage at the former place will, if carried through, modify these conditions to a considerable extent.

Private enterprise has, however, not been slow to seize on advantages which have been ignored by the public bodies, and there has been a steady and systematic search going on for many years for suitable industrial sites along the lower river.

In this class of prospecting, however, an intimate knowledge of the river is necessary, and no mere reference to estate plans or Ordnance maps will carry the prospective buyer very far. Unlike the objective before a quay or warehouse syndicate, the private factory owner has before him solely the requirements of his single trade, be it, for example, oil storage and refinement (import), cement (export), paper pulp (import), coal (import), &c. Assuming that his search for a suitable riverside property is based on the necessity of bringing ships alongside, he looks first for "deep water close in," as this enormously lessens his costs in building quays or jetties.

Private enterprise has, as a result, been steadily securing the best sites over the last quarter of a century. The Kentish shore in general does not offer the same facilities as the Essex. Since the war, however, some development has undoubtedly taken place on the Kentish side, notably the quay built by the Kent Portland Cement Works (now part of one of the cement combines) at Stone, near Dartford, and the extension of their deep-water jetty by the Empire Paper Mills, Greenhithe, in 1911. Further down river and actually just outside the Port of London boundary, the Medway Oil Storage Company also have a favourable site near Port Victoria and are rapidly developing it by means of a suitable deep-water berthage.

On the Essex side, however, the possibilities have proved greater. From Barking down river to the sea the first noticeable marine works is the series of jetties misnamed Dagenham "Dock," which, according to the Press, are to be converted by Messrs. Ford to the same uses as their quays in Cork Harbour, Irish Free State. Then follows the group of coal, paper, and oil storage undertakings with their jetties east of Purfleet. From here there is still a gap of some miles to Tilbury, excluding the small quays at and near Grays.

Beyond Tilbury for some distance mud flats exclude the possibility of immediate development, but beyond Mucking Light and as far as East Point, Holehaven, for a distance of 3 miles there exists the real "home" of the deep-water quay as far as London River is

concerned. Along this stretch of river there are several jetties where the biggest oil tankers can come alongside, and in two cases 30ft. of water at low tide within about 150ft. of high-water mark have been secured. The range of tide here is about 18ft. (Springs), so that the average gradient from the river bank to the river bed is nearly 1 in 3—a truly remarkable physical condition. Very similar conditions apply at Horseshoe Bay, in the Parish of Corringham, further down stream, where Messrs. Cory Brothers (oil department) are rapidly developing their new waterside depôt. The great natural advantage of the Essex shore is that the deep water occurs close inshore where the river is wide. On the southern or Kentish side this condition is reversed.

Now, without exception, all the sites referred to in the foregoing brief review (and, of course, many others) are within areas controlled by Level or Sewer Commissioners, part of whose duties are to maintain the river walls, as the lower Thames is for the most part bounded by low-lying marshes. These walls are little more than clay embankments protected by chalk and stone pitching, and they have come into being over many centuries as the marshes have been gradually reclaimed. This reclamation has in the course of time been followed by the gradual drying out and subsidence of the marshes to a level now several feet below that of high water.

The most economical way to secure a deep-water berthage on such sites is undoubtedly to run out skeleton structures either in the form of a piled jetty and dolphins or in the more ambitious form of a continuous quay frontage with shore approaches. Some have been constructed with open piling in reinforced concrete or timber; some are carried on mass concrete cylinders, and a few are of composite design, including steel superstructures. The main points to bear in mind, however, from the navigation point of view are these:—

(1) The class of quay accommodation referred to above is different in character from the more massive type of "solid fill" quays found in the upper reaches. The latter afford real protection against possible damage to river walls, as they themselves represent an obstruction of a really adequate character capable of preventing a ship in the ordinary way from running ashore.

(2) In the event of collision with marine structures due to fog, failure of steering gear, or errors in navigation, generally speaking, the ship will suffer more than the structure if the latter is of the solid character, *i.e.*, concrete or masonry or brick walls with solid filling behind.

(3) The latter condition does not, however, apply to the relatively new quays in the lower reaches, and a sequence of accidents recently has shown that comparatively small ships with little way on them pass through or seriously damage these open structures with far more damage to the latter than themselves.

(4) These new piers and jetties project generally from 150ft. to about 600ft. into the river to reach a depth of at least 30ft. of water at low tide. They and the dolphins (if any) are lit at night with the usual twin up and down-stream pierhead lights.

(5) By nature of deep water being close-in these jetties are naturally close to the fairway.

(6) Owing to the fact that shipping always represents a series of uneven departures and arrivals, there are times when a number of large ships are found anchored in close proximity to these new berths, awaiting their turn to come alongside.

(7) The combination of the lights of inshore ships at anchor with those on new pierheads and dolphins have entirely altered the down-river aspect of the Thames at night.

(8) No special system of night sea-marks to cope with this difficulty appears to have been adopted by the P.L.A. below Mucking Creek.

(9) The nuisance of ships coming ashore by day and by night is increasing.

(10) The possible and potential damage which would occur if a ship at high tide actually breached the river wall almost beggars description.

In regard to the last point, on the night of April 7th–8th last (1924) a small ship of 885 tons register nearly succeeded in performing this feat. She came ashore at high tide and her stem came to within 2ft. of the crest of the wall. A few feet further and the tide would have been through the wall and a most valuable industrial property now being newly developed would have been involved. These clay walls also suffer below low-water mark, as, if the ship remains beached, as the tide falls a "blister" or rise in the benching of the wall is caused by the downwards pressure of the ship as she settles, the material squeezed from under her bilge escaping upwards in the near vicinity, thereby definitely raising the revetment and disturbing the toe of the wall.

The wharfingers can do little to guard against this class of damage, though they are naturally apprehensive of breaches being caused in their defences.

Has not the time come when some inshore beacons should be provided to perform the specific function of keeping shipping clear of the pierheads and river walls?

THE new filtration plant of the Kilmarnock Corporation waterworks, which has just been put in service, is capable of dealing with three million gallons of water a day.

The North-Eastern Werkspoor Double-acting Marine Oil Engine.

No. II.*

IN our article of last week some account was given of the leading particulars and the principles of design, on which the single-cylinder double-acting marine oil engine, built jointly by the North-Eastern Marine Engineering Company, Limited, of Wallsend, and the Werkspoor Company of Amsterdam, is based. Briefly summarising this description, it may be said that the new experimental engine follows closely existing four-stroke cycle practice, as used on single-acting Werkspoor engines, except that in the new design the underside of the cylinder is enclosed by a water-cooled cover, through which the piston-rod passes, and a separate bottom combustion chamber communicating with the under side of the piston is provided at the front of the engine. This chamber is furnished with the usual fuel, inlet, and exhaust valves which are operated by rods from the top platform cam shaft. The general arrangement of the engine as it appears on the test bed is shown by the engraving reproduced on page 630. The engine is designed for a maximum output of 1000 indicated horse-power when running at a normal speed of 95 revolutions per minute, the diameter of the piston being 31½in. or 800 mm., and the stroke 55in. or 1400 mm. Under normal load and at the same speed 600 brake horse-power is developed, which compares well with the 360 brake horse-power which would be developed by a single-acting engine of similar dimensions, and shows a gain of between 70 and 80 per cent., achieved by the application of the double-acting principle. This result has been obtained with a very moderate loading of the bottom side of the power cylinder, and the successful results would seem to indicate that the design leaves room for still further gains. The excellent performance of the large engine owes much, no doubt, to the initial work done on an earlier experimental engine, illustrated in Fig. 2, which was built by the Werkspoor Company, and run in its Utrecht works for a period of over 18 months. It also had a single cylinder which had a bore of 17¾in. or 450 mm., and a stroke of 26¾in. or 680 mm. As the engraving reproduced in Fig. 3 shows, the bottom combustion chamber for the first engine was placed at the side of the engine and not at the front. Experience, however, proved that a more convenient arrangement of valve operating gear could be adopted with a front bottom combustion chamber, and this arrangement was adopted on the large engine.

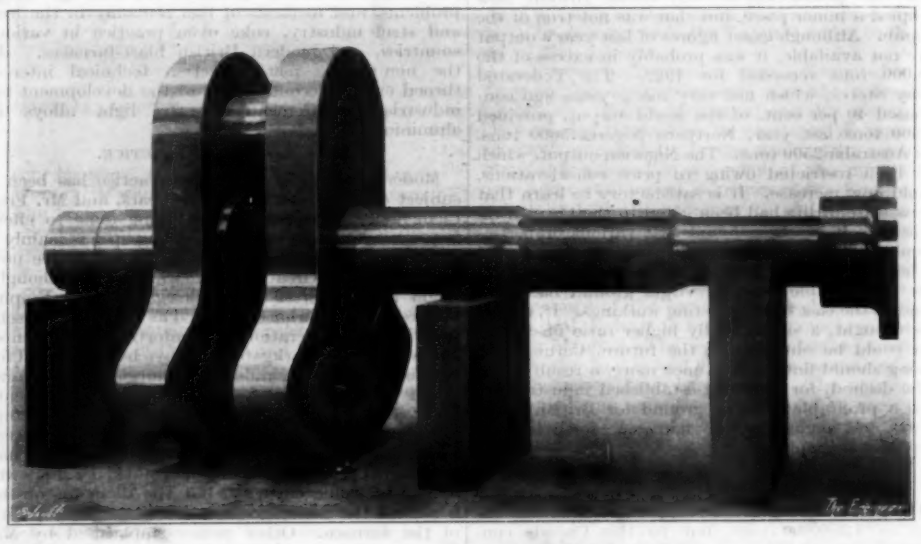


FIG. 2—UNITY BUILT-UP CRANKSHAFT

SOME ENGINE DETAILS.

The main crank shaft, which is a particularly fine example of the Unity method of crank shaft construction developed on the North-East Coast by the North-Eastern Marine Engineering Company, Limited, and by Richardsons, Westgarth and Co., Limited, is shown in Fig. 2. This shaft, which is over 15ft. long and about 7ft. 6in. high with journals 18½in. in diameter, is made in five pieces, the two portions of the shaft, the crank pin and the two webs being prepared separately. The webs are shrunk on to the shaft and pin, and it is interesting to note the curved slots through each web, which were made in order to ensure equal shrinkage, and to avoid the distortion which would have occurred had the effect of the large masses of metal forming the solid balance weights not been countered by this means. The ends of the shafts and the pin are turned down to leave a wedge-shaped opening between the circular shaft and the web; this space is welded up solid and caulked in, making a permanent and solid connection. The welding at the crank pin on the outside of the web and also on the raised boss between the webs on the left-hand portion of the shaft can be seen in Fig. 2. The shaft is keywayed to take the 15ft. dia. 24-ton fly-wheel, and a journal is provided for the Michell type outboard bearing, shown on page 630.

The connecting-rod and the crosshead guides do not call for special consideration, as they closely follow the accepted lines of marine practice. Some mention may, however, be made of the piston. It is formed in two parts, and the top is furnished with seven rings and the bottom part with five, an annular space being formed between the two parts. The existence of this space is made to serve a very useful and novel purpose. A passage is contrived through the liner to the intermediate space between the upper and lower parts of the piston, and at a certain point in the revolution communication is made through a horizontal mechanically operated valve with a gauge near the control platform. The normal pressure is found to be 50 lb. per square inch, and if higher pressures are recorded the attendant is at once made aware of the fact that the piston is allowing the gases to blow back, and attention is required.

In our first article we dealt with the arrangement of the upper and lower valves, which are identical in size and interchangeable, and described the provision which is made for warming up the bottom combustion space by hot exhaust gases from the top of the cylinder until it becomes hot enough to fire the oil charge. During this preliminary heating-up period the bottom exhaust valve is held open until the time comes for the injection of fuel into the bottom combustion chamber space.

The gear for accomplishing the changing over of the bottom cylinder to fuel is of interest. In the engine we are describing the starting shaft at the floor level control platform is operated by an electric motor. A dial in the forefront of the motor shaft has the four following positions:—"Stop," "air top," "fuel top," "fuel top and bottom." When the pointer is at either of the three first positions the top cylinder valves perform their normal function, but the bottom exhaust valve is held wide open and the bottom air inlet valve is shut. On the third position being reached the engine is firing on fuel at the top side of the piston, and the hot exhaust gases are being drawn in and expelled from the bottom cylinder and combustion spaces. A pyrometer attached to a part of the bottom exhaust valve port indicates when the temperature has increased to a sufficient degree. As soon as 400 deg. to 450 deg. Fah. is reached at the combustion chamber, fuel may be injected, and under the cylinder compression pressure self-ignition will automatically take place. The starting shaft is then put into the fourth "fuel top and bottom" position, and the bottom exhaust and inlet valves come into full operation, rendering the engine completely double acting. This combined operation seems somewhat long and complicated to describe in words, but in practice it is very simple and works without any trouble. The arrangement of the starting gear on the control platform will be seen in the accompanying illustration.

TRIALS AND RESULTS.

Since the engine was first erected in January last various trials have been run under different conditions of loading and with several varieties of fuel oil. As will be seen from our illustration on page 630, the testing equipment is a very complete one. The engine is coupled directly to a Heenan and Froude water brake designed to be capable of absorbing up to

* No. I. appeared May 30th.

6000 brake horse-power. Two of the latest type of Avery weighing machines of the combined steelyard and dial pattern are used to check the weight of fuel used, and the ready-use tanks are fitted with electric heaters. All auxiliaries are electrically driven, and they comprise a three-stage air compressor, a cooling water circulating pump, and the lubricating oil pump. Arrangements are made to maintain the cooling water inlet temperature at any desired figure. We noted that a De Laval type of centrifugal purifier is installed for the cleaning of lubricating and fuel oil and that an aspirator tank and ejectors are used to withdraw samples of the exhaust gases for analysis. The most notable of the trials was a non-stop run, which was made last month and which lasted for twenty-four days, the engine for twenty days being under the direct supervision of the different classification societies. We were present when the engine was opened up on the morning of May 23rd, and the occasion was of double interest on account of the excellent state of the valves, pistons and liner, and the ease and rapidity with which the engine was dismantled and access to all parts given. The procedure for examining the piston is as follows, and is illustrated by Fig. 4. After a cast iron plate on the top of the crank case has been removed, a tube made in two halves is clamped round the piston-rod—see Fig. 4—its lower end resting on the crosshead. The engine is then barred round until the top end of the tube butts against the bottom cover of the cylinder. The bolts which join the upper and lower parts of the cylinder casings and liner can then be removed, and when the engine is turned down the bottom portion of the cylinder comes down with it until the bottom cover rests on the crank case top plate. As shown in Fig. 4, there is then an opening between the two parts of the cylinder, and the tube can be removed from the piston-rod and the engine moved round until the piston is opposite this opening, where it is immediately accessible for examination or removal.

In opening out the engine the bottom combustion chamber cover was removed and the loose liner taken out, which gave full access to the combustion space and the piston-rod in a few minutes. All surfaces were remarkably clean and free from carbon deposit and were cool enough to be touched with the hand. The air and exhaust valves were removed from both top and bottom. The carbon on the exhaust valves was very moderate, the seats were in excellent condition, and the air inlet valves were quite clean. The main piston was exposed within one hour of starting the dismantling operation and the rings were found to be perfectly free and well lubricated. The same remark applies to the cast iron packing rings of the piston-rod gland. Within three hours the two halves of the piston and the gland packing rings were removed and laid on the platform for inspection. An interesting proof of the exceedingly low temperature of the bottom cylinder space was given by the fact that two fusible plugs fitted into the piston-rod flange immediately below the bottom half of the piston were both unmelted. One was set to fuse at 160 deg. Fah. and the other at 200 deg. Fah.

As to the results obtained during the run, they, we understand, will form the subject of a special report. The fuel consumption and power trials were supervised by Professor Hawkes and his staff, and Professor Hawkes' report will be awaited with interest. The minimum fuel consumption obtained was, we are informed, about 0.40 lb. of oil per brake horse-power hour, using Anglo-American Diesel oil of 0.91 specific gravity. An interesting feature of the twenty-day non-stop run was the daily log which was kept by the staff. This run corresponds exactly to a 7000-mile non-stop voyage from Colombo to the Tyne at a speed of 14.5 knots with the engine running at 95 revolutions per minute. The distances which would have been travelled daily were marked off on the chart and when the time for stopping the engine came it was found that the home port had been reached in good time. Opinion has been expressed that the engine we have described is somewhat tall for its power. To give a standard of comparison the size of a reciprocating steam engine of equal power was drawn out on the wall of the test house, showing that there was little difference between the two engines.

More particulars regarding this new and promising engine are to be given, we learn, in a paper which will be read by Mr. Harry Hunter and Mr. G. T. Lugt, of Amsterdam, before the summer meeting of the Institution of Naval Architects, which will be held in London at the end of the present month.

FIG. 3—FIRST WERKSPOOR DOUBLE-ACTING ENGINE

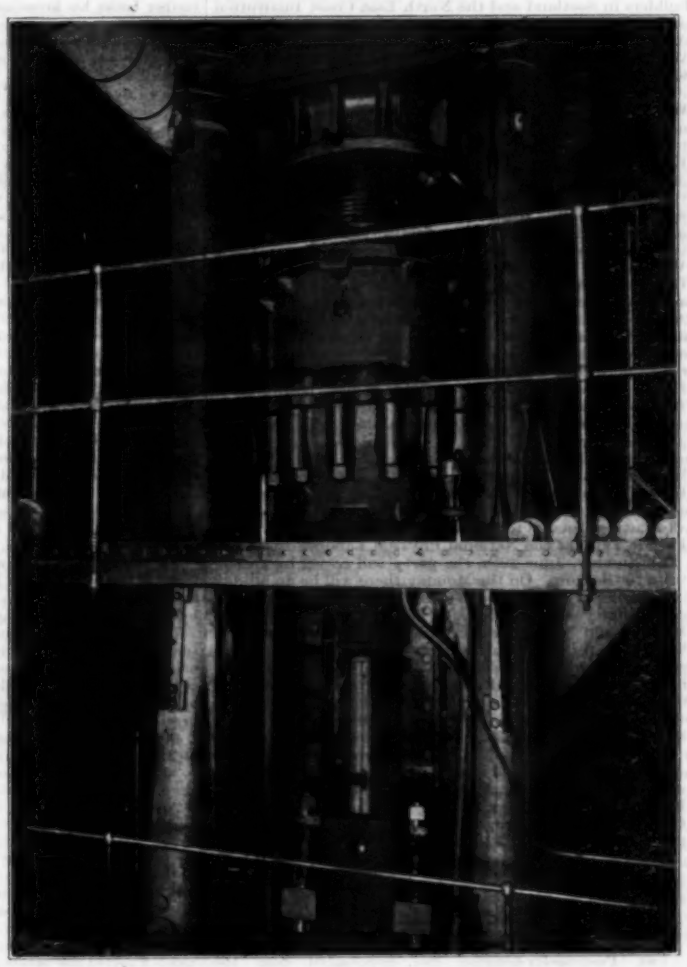


FIG. 4—METHOD OF GETTING ACCESS TO PISTON

The Motor Ship Dolius.

THE motor ship Dolius has now returned from her maiden voyage to Algiers, and after discharging her cargo at Rotterdam last week end, left for Birkenhead *en route* for a further voyage to the Dutch Indies and the Far East. Through the courtesy of the Still Engine Company, Limited, we are enabled to give some particulars of her recent voyages. She was built, it will be remembered, for the Blue Funnel Line, Alfred Holt and Co., Limited, of Liverpool, by Scott's Shipbuilding and Engineering, Limited, of Greenock, and is the first ship to be driven by Scott-Still marine oil engines. Her overall length is 423ft., her breadth 52ft., and her depth 32ft. At a displacement of 11,370 tons she draws 25ft. 6in. She was designed for a service speed of 11 knots, and an estimated daily consumption of about 10 tons of fuel.

Twin-screw four-cylinder Scott-Still two-cycle oil engines are installed, to run at a normal speed of 120 revolutions per minute, developing 2500 shaft horse-power. The diameter of the cylinders is 22in. and the stroke 36in. Steam, raised in a special boiler which recovers the larger proportion of the heat usually wasted in the exhaust gases and cooling water, is used expansively on the under side of the main piston, the combustion space being reserved for the oil fuel which is injected mechanically. All the auxiliary machinery is electrically driven.

Detailed particulars of these engines were given in articles which appeared in THE ENGINEER of November 23rd and 30th, 1923, while on April 11th of this year we described the trials of the ship. On the test bed trial a fuel consumption of 0.356 lb. of fuel per brake horse-power was obtained. On her maiden voyage the Dolius left Cardiff at 7 p.m. on April 19th with practically a full cargo of coal and arrived at Algiers at 6 p.m. on April 24th. Out of the total time teken of six days less one hour, 5 days 6 hours were run at full speed; for the remainder of the time speed had to be reduced owing to fog. The miles (naut.) by ship at full speed were 1443, while miles (naut.) by screw were 1506, giving a percentage difference for the voyage between these two values of 4.18 per cent., while the total distance travelled was 1601 miles (naut.).

The average speed for the voyage—fog excluded—was 11.45 knots by distance run. For the last 48 hours revolutions were raised to between 128 and 130 per minute and a speed of 12 knots by distance run was attained. The engine counters showed 933,280 revolutions for the port engine and 945,860 for the starboard unit, giving an average of 123.4 revolutions per minute for the port and 125.0 for the starboard engine for the full speed time. The average mean indicated pressure on the combustion side was 65.15 lb. for the starboard and 62.7 lb. for the port engine, while on the steam side the figures were 5.46 lb. and 5.56 lb. per square inch respectively, when the ship was doing 12 knots as mentioned. Comparing these figures with the test bed figures the engines are shown to have a considerable margin of power which should greatly add to their reliability in regular service.

The overall fuel consumption, including all auxiliaries, steering, lighting and cooking, &c., worked out to 8.387 tons per day of 24 hours. On leaving Cardiff the draught of the ship was 24ft. 11in. forward and 25ft. 2in. aft, and on her arrival at Algiers measurements of 24ft. 1in. forward and 24ft. 10in. aft were registered. The average displacement of the ship for the voyage was 10,840 tons. In connection with the figures above given, a very interesting method of comparing ships of a similar class is to use a modified form of Admiralty coefficient which is obtained by substituting the average daily weight of fuel consumed for the average indicated horse-power in the denominator of the fraction; we then have the formula: $\frac{D^{\frac{2}{3}} \times K^3}{\text{Fuel consumed}}$ where D is the actual average

displacement of the ship for the voyage in tons, K the speed in knots, and the oil consumed is expressed in tons used per 24 hours. Using the values observed on the voyage, this coefficient works out at 87,670 for the Dolius, which, as far as we are aware, is a figure which has not yet been equalled by existing motor ships.

On the return voyage from Algiers to Rotterdam, which was made with a full cargo of iron ore, an average speed of 10.81 knots by distance run was maintained, with a fuel oil consumption of 8.239 tons per day of 24 hours.

Throughout the voyage no trouble with the machinery was, we learn, experienced, and there were no slows for anything other than bridge orders. At Algiers the ship was manœuvred from the discharging berth to the loading berth, and although in a congested harbour her manœuvring powers proved to be so excellent that the services of the tugs were not utilised. On arrival at Algiers and again at Rotterdam cylinders were opened out, and we learn that the engine was found to be in excellent condition.

The Dolius certainly seems to have upheld and surpassed the excellent figures which were obtained during the test runs, and the results of the maiden voyage should be most satisfactory to her owners.

INSTITUTION OF NAVAL ARCHITECTS.

JOINTLY with the Institution of Engineers and Shipbuilders in Scotland and the North-East Coast Institution of Engineers and Shipbuilders, the Institution of Naval Architects will hold its summer meeting in London from Wednesday, June 25th, to Saturday, June 28th. Visits will subsequently be paid to Glasgow and Newcastle.

The following programme has been arranged:—On Wednesday, June 25th, at 10 a.m., the opening of the meeting by the Duke of Northumberland, president, will take place in the Great Hall of the Institution of Civil Engineers, after which there will be reading and discussion of papers. In the afternoon there will be a reception by the President and the Duchess of Northumberland at Syon House, Brentford. In the evening, at 7.30 p.m., a banquet will be given by the Institution of Naval Architects at the Connaught Rooms, Great Queen-street, W.C. 2. On the Thursday a visit will be paid to the British Empire Exhibition, where there will be a reception and luncheon, given jointly by the Institution of Naval Architects, the Institution of Engineers, and Shipbuilders in Scotland, and the North-East Coast Institution of Engineers and Shipbuilders. In the evening, at 10 p.m., a reception will be given by H.M. Government at Lancaster House, St. James' Park. On the Friday morning, at 10 a.m., there will be reading and discussion of papers at the Institution of Civil Engineers, and in the afternoon a trip on the river Thames in a special steamer has been arranged to visit the docks and shipping of the Port of London, the departure being made from Greenwich Pier. In the evening, at 9 p.m., a concert and supper will be given at the Hotel Cecil. On the Saturday afternoon there will alternative visits (*a*) to Windsor Castle, or (*b*) to the William Froude Tank at the National Physical Laboratory.

On Sunday, June 29th, the party will travel by special train to Glasgow. On the Monday there will be an all-day trip on the Clyde by special steamer, which will include a garden party at Brodick Castle, Isle of Arran, given by the Marquis and Marchioness of Graham. In the evening a banquet will be held in the Grosvenor Restaurant, Glasgow, given by the Institution of Engineers and Shipbuilders in Scotland. On the Tuesday morning there will be alternative visits to the works of either G. and J. Weir or the Fairfield Shipbuilding and Engineering Company. In the afternoon the party leave by special train for Newcastle. On the Wednesday, in the morning, there will be alternative visits to shipyards and marine engineering works, and in the evening a banquet given by the North-East Coast Institution of Engineers and Shipbuilders. On Thursday, July 3rd, a return will be made by special train to London.

LONDON-BRISTOL TELEPHONE CABLE.

THE Postmaster-General has announced that the London-Bristol telephone cable, which is one of the main links in the network of underground cables now in course of construction, will be brought into service on Monday next, June 2nd. The cable, which is 122 miles in length, will be the channel for communication between London and the West of England. It will also enable direct communication to be established for the first time between London and Plymouth. As a part of the country's underground telephone network, which is intended to replace the overhead lines and provide a telephone system practically immune from damage by storms, it is so designed that in the event of any fault developing on, say, the London-Birmingham cable, communication between London and Birmingham may be maintained *viâ* Taplow, Marlborough, Bristol, and Gloucester.

All the main links in the underground system contain a number of lines specially designed to form eventually a part of an international underground network of telephonic communication between the United Kingdom and the chief continental cities, on the lines discussed at the recent Conference in Paris. The London-Bristol cable follows the Bath-road over almost the whole route.

The cable contains 616 wires, which could provide 462 channels of communication, so that very rapid connection should be possible. The total weight of copper per mile of cable is approximately 5½ tons. On an overhead road line the same amount of copper would provide only sixty wires. This reduction in the weight has been rendered possible by the introduction of telephone repeaters whereby electrical speech currents are magnified at intermediate points. The cable is divided into three sections by repeater stations at Taplow and Marlborough. The Taplow station is the first of a series of large, independent repeater stations for operation in connection with the national and international telephone services and will be followed in time by similar stations at various points of the underground network. It is equipped with some of the most delicate apparatus used in telephony, a vital element being a thermionic valve, which is marked by important differences in design from the wireless receiving valve. The telephone repeater valve is the result of many years of research work on the part of the Post Office engineers, assisted by the research establishment of the General Electric Company.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

FLUID FRICTION.

SIR,—I was interested by some parts of the article in your last issue—May 30th, 1924—but especially by the wide variation shown by different theories.

Dr. Morley apparently adopts the Chezy theory of $(R\,s)^{0.5}$, also found in most of the older formulæ combined sometimes with cumbrous formulæ for finding the true (?) value of "*c*." Dr. Morley and the authorities he quotes adopt this method, but the crucial test of all such pipe formulæ is whether or no the calculated results agree with experiment.

Barnes, on the other hand, by a somewhat elaborate method produces evidence that for any class of pipe *c* is a constant, and that the Chezy formula should be written $v = (R^a S^b)\,c$, *a* and *b* being less than unity, but not necessarily = 0.5. He further backs his investigation by comparison with numerous experiments, and shows a somewhat remarkable concordance between calculated and experimental results. It appears to me that we are very much up against it. Which theory is nearest the true facts?

As to the roughness of the channel producing turbulence of flow, Herschel and others have quoted examples which go to show that even extremes of obstruction cause little, if any, reduction in the discharge of large conduits. Does not this go to show that "roughness" is, in itself, of minor importance, unless general to the whole wetted surface, and as there is no "standard of roughness," we have no basis on which to compare formulæ and arrive again at our starting point, which bases the practical use of a formula on average experimental results, trusting that our calculations for a particular case will fit our final results, after spending other people's money for them, "near enough."

Since the density of water varies with temperature, this is taken into account by Dr. Morley. Hamilton Smith and others have been careful to record the temperature when making their experiments, conjecturing that temperature may affect the discharge. But does it do so, or if so, is *v* and therefore discharge influenced by temperature to any noticeable extent within the range of temperature usually met with? Further, may not turbulent flow, *i.e.*, varying local velocities which when averaged on a line parallel to the axis of the conduit, give the average velocity of discharge = *v* be produced by other causes than "roughness," a bend in a pipe for instance? Now, since the effect of the bend would vary with the velocity of flow, we should have to introduce a further term into our formula, representing the effect of an unknown velocity of flow on the final velocity of discharge.

I am much afraid that we should finally arrive at a scientific formula built on German lines and of such a terrifying aspect that even the full Kutter's form would be reckoned child's play by construction and designing engineers.

These remarks are not intended to belittle the value of scientific research; far from it, and if not helpful constructively, may be so indirectly. Personally, I doubt if it is possible to construct a formula for the hydraulic discharge of pipes, &c., of strictly scientific accuracy and not too overwhelming for practical use. There are too many variables in practice. If I am correct, then practical engineers must be content to rely on formulæ based on practical results, and averaged by reference to numerous trials after construction.

GEO. T. PARDOE.

Angmering, June 2nd.

THE FIRST UNI-FLOW ENGINE.

SIR,—While searching amongst some old locomotive cuttings and sketches, I came across an outline arrangement of an inside single-driver engine, with a cylinder section alongside it that considerably surprised me. I have no record of the source from which I copied the outline, but the name given on a nameplate shown on the boiler barrel is Maid of Kent, and the cylinder section shows exhaust ports at the middle of the cylinder length, an extra long piston of built-up form also being shown.

Recently, your contributor, Mr. E. L. Ahrons stated that in 1843 the firm of G. and J. Rennie built their last two locomotives, which were named Man of Kent and Maid of Kent, one of which was taken over by the Brighton Railway and the other by the South-Eastern Railway. These two locomotives would therefore seem to be the first uni-flow engines ever built, and to have anticipated by many years the Nicholson engine, as built by Stewarts, of Blackwall, as well as the Leonard J. Todd invention of 1887, the W. F. and E. W. Cleveland engine on the Intercolonial Railway of America in 1900, and the Professor Stumpf engine of 1908.

The outline arrangement does not indicate anything in the nature of the valve gear used, but in all probability the Carmichael gear was used, the link motion being at that time a purely Stephenson construction. In any case, the valve chest was placed at one end of the cylinder and extended to about half its length, this indicating either provision for the fitting of ordinary cylinders in the event of the central exhaust cylinders proving unsatisfactory, or that these cylinders had been worked into an existing design of engine with the least possible alteration, their front covers being shown very close to the front buffer beam.

Glasgow, June 2nd. JAS. DUNLOP.

THE FIRST CONTINUOUS AUTOMATIC RAILWAY BRAKE.

SIR,—In a paper "On the Retardation and Stoppage of Railway Trains," read by Wm. Fairbairn, of Manchester, before the Institution of Mechanical Engineers on December 7th, 1853, reference was made to various proposed continuous brakes, and continued as follows:—"One of the most practical, a plan invented some years since by Mr. Robert Heath, of Moseide, near Manchester, which consisted of break blocks fixed in slide bars on each carriage and worked by a lever with a weight upon the end of it, adjusted to give the requisite pressure upon the wheels. When the pressure of the breaks was required to be taken off, the ends of the levers were lifted by tension bars and chains, which extended the whole length of the train and were worked by a rack and pinion within reach of the guard . . . . the guard having only to release a catch in order to put on all the breaks at once, and employing his own power only in lifting off the breaks afterwards by means of the rod and chain communicating with each carriage."

"In a practical test of these breaks in 1848 with a train of five carriages and a van, all fitted with the breaks acting together and the tender break also used, the following results appear to have been obtained":—

Speed of train when breaks were applied.	Descending gradient.	Distance run after breaks were applied
40 miles per hour	1 in 100	148 yards
45 ,, ,,	1 in 100	163 ,,
50 ,, ,,	1 in 82	232 ,,
55 ,, ,,	1 in 200	264 ,,

So far as I can ascertain, no previous brake had the feature of automatically applying itself when the train parted, and this brake clearly anticipated the Wilkin and Clark brake in this country and the Ambler brake in America. It is, of course, remembered that the Westinghouse air brake when introduced into this country in 1872, while being a continuous brake, was in no sense an automatic brake.

If any of your readers can say what particular railway the Heath brake was tried upon or give any further details of the brake, I am sure many others, as well as myself, will be much interested and much obliged.

Glasgow, June 2nd. JAS DUNLOP.

LABOUR GOVERNMENT ORGANISATION OF LABOUR.

SIR,—I had the idea of the advantage of workmen unemployed handing over their share of the dole as part of their full wages to anyone who gave them constant work before I read that Sir Alfred Mond had adopted it as a policy. Most likely there are thousands of others who have had the same idea, and that he is the representative of all those.

Would it not be possible to go a step further and make it a rule that no persons should receive the dole unless they make an equivalent contribution of work to the State. That is to say, that if they receive £1 per week dole and the full wages when working are £3 per week, then they must give sixteen hours' work each week to the State. It would be the same as if the ancient Roman soldiers gave one-third of their time to work for the State in making roads, bridges, &c., while two-thirds was given to drill. The first great point is that this system would bring to an end the demoralising effect of receiving and living on dole. The second that we could get the work of the State done expeditiously and cheaply.

Say there are 1,000,000 unemployed receiving dole, then there would be 16,000,000 work hours per week given to State work—central electric stations, water power stations, docks.

Take the housing scheme. Mr. Wheatley, Dr. Addison, and the Government cannot think of any scheme which is not to cost enormous further sums. Why could not the scheme of building be made to suit the problem of the unemployed? It is not at all necessary that the scheme of building should be made to suit the bricklayers, brickmakers and trades unions in the building trade. Could it not be made so that it would suit the unemployed question? In getting out his scheme, should not Mr. Wheatley consult Mr. Shaw, and in looking for work for the unemployed, should not Mr. Shaw call in on his rounds to seek employment to see Mr. Wheatley, and ask him if he requires any work done to-day. In view, then, of the serious question of the unemployed, should not the building scheme be made to suit the unemployed?

Could not Mr. Wheatley say one day to such firms as Cubitts and S. Pearson and Sons, John Aird's, and many of the large contractors: "I do not want shells now or fuses; I want houses. You can build the houses of what you like, bricks or concrete or anything contained in our specifications. We will supply you with a million men, and you will only require to give them two-thirds wages; the remaining one-third will be dole, and for this advantage the houses are only to cost £250 each."

If Mr. Wheatley did this, would not he get his houses and live at his ease free from worry? In the hands of the great contractors, with a million hands at two-thirds wages thrown at them, does anyone doubt that the 2,000,000 houses would be got in a year, and without a single farthing of the £1,400,000,000 which Mr. Wheatley is worrying us to pay? One wonders what Lenin would have done with a million workers receiving £1 per week from the State. The trades unions did not try any monkey tricks with Lenin. They did not even dare to strike. But here under our Labour Government they—the trades unions—demand houses to be built under a Government-created trust, and will not pay the rents corresponding to the charges which they themselves have made for building them. How long will the majority of the people put up with such labour organisation?

London, June 4th. G. HALLIDAY.

CAPITAL AND LABOUR.

SIR,—In your leading article you direct attention to the food for thought which is to be found in Mr. Flanders' presidential address at Buffalo. While assimilating the latter, I came upon a tit-bit to which I cannot resist drawing attention.

He contrasts the modern methods of making holes in rock with those of fifteen years ago. Then: Three men and five dollars' worth of equipment. To-day: One man and 5000 dollars' worth of equipment. What about the relative importance of, and necessity for, Labour and Capital? This is not an isolated case; on the contrary, it is characteristic of the times.

C. F. DENDY MARSHALL.

Guildford, May 31st.

UNDER the auspices of the Institute of Chemistry Students' Association, a visit of students to the British Empire Exhibition has been arranged for Tuesday, July 15th next. The Chemical Section will be inspected under the direction of Mr. W. J. U. Woolcock, at 11.30 a.m. Prior to the inspection, a meeting will be held at 9.45 a.m. at University College, Gower-street, under the presidency of Professor G. G. Henderson, when Mr. Woolcock will explain the objects of the exhibits.

Railway Matters.

THE plant in the Great Western wagon shops at Swindon is being adapted to deal with the new type of 12-tons open goods wagon now accepted as standard by all the British railways. This type of wagon differs considerably from that now used by the Great Western.

IT is reported that Sir Herbert Walker, the general manager of the Southern Railway, has assured a deputation from Guildford that the electrification to that town will be completed by the end of 1925, and that a half-hourly service will probably then be provided.

THE new Cuffley-Hertford-Stevenage line of the London and North-Eastern Railway was opened on Monday last. It is 14 miles in length and has four stations. Hertford will continue to be served *viâ* Hatfield and so will still have the benefit of the fast trains that call at Hatfield.

ON page 548 of our issue of May 16th we noted that Sir William Mackenzie had been requested by the Central Wages Board to arbitrate on the question as to whether the pay of station masters, supervisors, and other salaried staff should not be increased when the cost of living rises, as it is lowered when the cost of living falls. An award in favour of the men's contention has now been made, and they are to receive £5 per annum for each five points increase.

THE London, Midland and Scottish Railway Company has recently given distinguishing names to its stations in towns where there are more than one station. The object that has, no doubt, prompted this action is rather the convenience of the company's own staff than the public's. The latter will, most likely, continue to speak of, for instance, the two stations in Bedford as the "Midland" and the "North-Western," rather than "St. John's" and "Midland-road" respectively.

As the result of the scheme for its absorption of the Leek and Manifold Light Railway, the London, Midland and Scottish Railway Company has agreed to pay to the Staffordshire County Council the sum of £7256, in settlement of the light railway company's liability in respect of loans advanced to it by the County Council. There remains a balance of £5781 owing on the original loans, which will necessitate a levy on the rates of the county of approximately £304 per annum for the remaining thirty-four years.

THE clerical staff on the Irish railways threaten to strike because of the failure of the Irish Railway Wages Board to arrive at an agreement regarding proposals for the betterment of the men's positions. As related in this column on the 16th ultimo, the Board failed to agree because of the uncertainty as to the future of the Irish railways. The matter affects Ireland as a whole and both Governments are endeavouring to come to terms with the staff, and have offered to submit the question to arbitration, to which the men have agreed.

IN this column on May 23rd mention was made of the sale of the Ulster and Munster of the City of Dublin Steam Packet Company. Only one point now prevents the winding up of that company, and that, said the chairman at the recent annual meeting, was giving the directors some concern. It is the guarantee given by the Steam Packet Company, the Dublin and South-Eastern and the Great Northern (of Ireland) railway companies towards the cost of the City of Dublin Junction Railway, a line, 1 mile long, which enables the mail trains on arrival in Dublin to reach Kingstown. Before the company can be wound up, this guarantee must be disposed of, but in view of the uncertain future of the Irish railways, this course is not practicable.

THE South Yorkshire Junction Company's absorption by the London and North-Eastern Railway was one of those which had to be left to the Railway Amalgamation Tribunal to decide. The reason for this course was that the Denaby and Cadeby Colliery Company was interested in the line, and by an agreement made between them a rebate was made of 3d. per ton on all mineral traffic exceeding a certain specified tonnage. The London and North-Eastern refused to accept this obligation, but the Tribunal inserted a clause in the amalgamation scheme to ensure a continuance of the rebate. The Court of Appeal ordered the Tribunal to state a case, which has just been heard, with the result that the deletion of the clause has been unanimously agreed to.

AS we went to press last week the *Railway Review*, the organ of the National Union of Railwaymen, appeared with an announcement that set at rest the fear of further trouble with the enginemen. The companies say, as we anticipated, that they "have found some difficulty in carrying out the terms of the agreement owing to the absence of any full and accurate information. . . ." They have therefore taken certain action, of which the *Railway Review* says:—"The companies' decision is cordially welcomed, as there are scores of cases where men have done as much as eleven months on the 14s. rate, but have not completed many turns which technically fall within the category of train turns. A large number of men will come on the 15s. rate immediately and the advance of others will be accelerated."

ACCORDING to the Board of Trade returns, the value of the railway material exported during the four months ended April 30th last was as follows, the corresponding figures for 1923 and 1922 being added in brackets:—Locomotives, £794,292 (£1,149,021, £2,341,566); rails, £631,131 (£813,786, £1,297,255); carriages, £358,316 (£422,093, £680,342); wagons, £1,325,816 (£999,504, £1,754,585); wheels and axles, £257,513 (£346,591, £586,614); tires and axles, £233,467 (£145,065, £200,464); chairs and metal sleepers, £564,672 (£261,291, £839,556); miscellaneous permanent way, £450,781 (£364,890, £626,552); total permanent way, £2,225,514 (£2,017,205, £3,633,931). The weight of the rails exported was 70,033 tons (90,605 tons, 123,341 tons), and of the chairs and metal sleepers 44,417 tons (22,808 tons, 59,877 tons). During the month of April, 1924, locomotives of the following values were shipped:—To India, £152,105; Argentine, £12,937; South Africa, £10,200; and rails of the following values:—British West Africa, £25,211; Argentine, £22,298; India, £18,392; Australia, £5752; New Zealand, £2643.

Notes and Memoranda.

AN experiment is being made near Cape Town in converting some sand dunes into forest area, by covering them with a carpet of domestic refuse, sowing the area with marram grass, and then distributing the seeds of an Australian wattle tree.

THE Commonwealth steamer Fordsdale, the largest ship Australia has yet built, has been fitted with an automatically-controlled speaking apparatus, which will enable conversation to be carried on under any conditions between various parts of the ship. The instrument, which is called the "Binghamphone," is the invention of an Australian, Mr. H. E. Bingham, is installed on the bridge, and is connected with the forecastle, crow's nest, steering compartment, engine-room, and docking bridge. It is reported that successful tests of the invention have been made during the trial run of the Fordsdale.

IN his comments on the failure of the blow-down bend of a Lancashire boiler at Winnington, the Engineer Surveyor-in-Chief, Board of Trade, says:—"Very severe stresses are imposed on elbow pieces of this type owing to lateral movements of the pipe lines due to expansion and contraction under varying temperatures, and failures attended with fatal results have occurred. The owners have now wisely adopted steel for cast iron in the replace fittings, and, what is equally important, have provided greater flexibility in the blow-down range of pipes. These alterations will effect much improvement from the safety point of view."

OFFICIAL Report No. 2658 deals with a rather unusual type of explosion of a water-tube boiler. One of the tubes connecting the steam spaces of the top drums pulled out at one end. Fortunately, no great harm was done. It was found that the tube had wasted away to $^1/_{16}$in. thick, where it was expanded into the tube plate, and was only $^1/_{32}$in. at the end. The method of fitting the tubes by expanding them so as to form a slight collar on each side of the tube plate, supplemented by a slight widening of the mouth of the tube, does not provide a secure attachment when the tube ends become unduly thinned, either from erosion or corrosion, and the explosion illustrates the need for careful examination of all these parts.

TO serve as a standard of radio frequency the Bureau of Standards has two specially constructed wave meters covering the frequencies in more general use from 18 kilocycles to 4600 kilocycles per second—16,650 m. to 65 m. Each consists of a variable air condenser of special design, four fixed mica condensers, a number of interchangeable inductors or coils, and a resonance-indicating device. The majority of the inductors are wound with high-frequency cable in a single layer upon a skeleton frame of laminated phenolic insulating material, sometimes called bakelite. The wave meter is tuned to a source of radio-frequency currents by varying the air condenser and obtaining the maximum deflection of an indicating instrument which is connected to two turns of wire and loosely coupled to the inductor in the wave meter circuit.

THE May issue of *Science Abstracts* refers to a balancing machine for large rotors. It is claimed that better balancing can be obtained more quickly than by any other method. The principle of the machine consists in placing the rotor in bearings mounted in pendulum supports, with springs which permit small lateral motions. The rotor is driven at the speed corresponding to the natural frequency of the system, so that a large and measurable amplitude of vibration is obtained. In this machine, the bearings are supported by inverted pendulums, suspended by flexible members from a bracket underneath the bearing The natural frequency can be varied by changing the springs. The balancing speeds are from 100 to 300 revolutions per minute, and rotors up to 230,000 lb. weight have been balanced on this machine.

SOME tables in the April issue of *Vulcan* give some interesting information concerning electrical breakdowns during 1923. Direct-current motor and generator armatures head the list, not only as regards the percentage of breakdowns, but also as regards percentage of cost. The tables relating to alternating-current machines show that the rotor of the squirrel cage motor is of much more robust construction than the rotor of the slip-ring motor. The percentage of breakdowns of rotors in the case of the squirrel cage motor is 14, as against a percentage of 35 in the case of the slip-ring induction motor. Although the percentage of breakdowns to stators for slip-ring machines is only 28 as compared with a percentage of 35 in the case of rotors, the percentage cost of repairs to stators is considerably in excess of the percentage cost of the repairs to rotors. This is in all probability accounted for by the fact that in a very large number of cases the breakdowns to stators necessitated the complete rewinding of the stator, whereas frequently the rotor repairs have been of a minor character.

ACCORDING to a memorandum recently issued in the United States, development of a line-radio or "wired-wireless" system, by which trolley wires, mine tracks, compressed air and water piping, cables and similar "carriers" are utilised for voice-transmission purposes, promises the solution of the difficult problem of establishing methods of communication between underground mine workers and the surface which would be reasonably sure to withstand the severe disturbances occasioned by mine explosions. Mr. J. J. Jakosky—assistant engineer, United States Department of the Interior—who is making a special study of the matter at the Pittsburgh Experiment Station of the Bureau of Mines, reports that in tests recently conducted in a coal mine 400ft. deep, no difficulty was experienced on the surface in receiving messages from a transmitting set mounted upon a mine locomotive so long as the apparatus was in the vicinity of metallic carriers. The experiments indicated that the transmitting range of a wireless set in the average coal mine is only a few hundred feet when no conductors are present, but may be several thousand feet when operating in proximity to metallic carriers. The Bureau found that breaks in the metallic conductors do not completely stop communication as in the case of a break in the lines connecting the ordinary mine telephones.

Miscellanea.

A SWEDISH Industriés Fair is to be held at Gothenburg on August 4th to 10th inclusive.

IT is proposed to extend the Upper Stour Valley main sewerage scheme, at a cost of some £50,000.

IT is probable that the Barnsley Pit of the Rotherham Main Colliery, which has been closed since early in 1921, will be reopened shortly. It should give employment to from 700 to 800 men.

IT is stated that Vickers Limited, of Barrow, have secured the Howden aerodrome property for the carrying out of a Government contract in connection with the construction of a new airship.

THE Government Purchasing Bureau of the Netherland East Indies has recently set up a permanent sample showroom at Bandoeng, where standard samples of engineering goods will be on show for inspection by interested parties.

THE total cost of the entire Hetch Hetchy project from the mountain reservoir to Crystal Springs reservoir on the San Francisco peninsula, according to a recent statement by M. M. O'Shaughnessy, city engineer of San Francisco, will be 78,000,000 dollars.

AN expedition left Sydney, New South Wales, early in April to take up an area under the first oil licence granted in the mandated territory of New Guinea. The area is 1000 square miles between the Sepik River and the coast, about 85 miles east of Eitape.

A CONTRACT has been signed by the British Empire Steel Corporation with German buyers for one and a quarter million tons of iron ore from Bell Island mines, delivery to be within six months. To carry out the terms of contract, a fleet of 20 steamers, averaging 10,000 tons each, will be required to transport the iron ore to Germany.

IN 1922, 3476 motor cars and 523 lorries, valued at £881,137, were imported into Australia. During 1923, 12,359 cars and 1585 lorries, valued at £2,421,045, were imported. These figures show that the importations of cars and lorries have been trebled during the year. In 1922 the value of motor cycles imported was £54,569, whereas for 1923 the value was £142,417.

IT is reported that the British Broadcasting Company is about to inaugurate a series of educational lectures and addresses which may be likened to a University Extension course, and to assist it the Board of Education has nominated one of its inspectors, Mr. J. C. Stobart, to become Director of Educational Broadcasting, and he will take up his new post in August. One series will be on health questions, under the supervision of the Ministry of Health.

A RECORD output from a deep pit has, says the *Iron and Coal Trades' Review*, been achieved at Brodsworth Main. In one shift of six hours and forty minutes, no fewer than 3209 tons 17 cwt. of coal were drawn up, an average of 8 tons a minute. Success has attended the sinking in the third shaft of Brodsworth Main, coal having been reached at a depth of 505 yards. The new, or No. 3 shaft, will take the place of the upcast shaft in the working of the Barnsley seam.

RAISING the level of the Welland river at the point of its crossing by the Welland Ship Canal, the enlargement of which will do away with the present aqueduct, has not been definitely decided upon, so a delegation from Welland was informed by the Minister of Railways and Canals, from whom information on the subject was sought at Ottawa. Such changes in the river level would mean the disruption of the present waterworks and sewer systems of the city, the cost of making them conform to the new level being estimated at 1,250,000 dollars.

THE Board of Trade, having had under consideration certain difficulties which have been experienced by junior engineers on large merchant vessels in obtaining sufficient service under the present regulations to qualify for the examinations for certificates of competency, has issued fresh instructions to examiners of engineers and a new notice to candidates in connection therewith. Copies of these instructions and the notice may be obtained on application to the Mercantile Marine Department, Board of Trade, 3, Sanctuary-buildings, Great Smith street, London, S.W. 1.

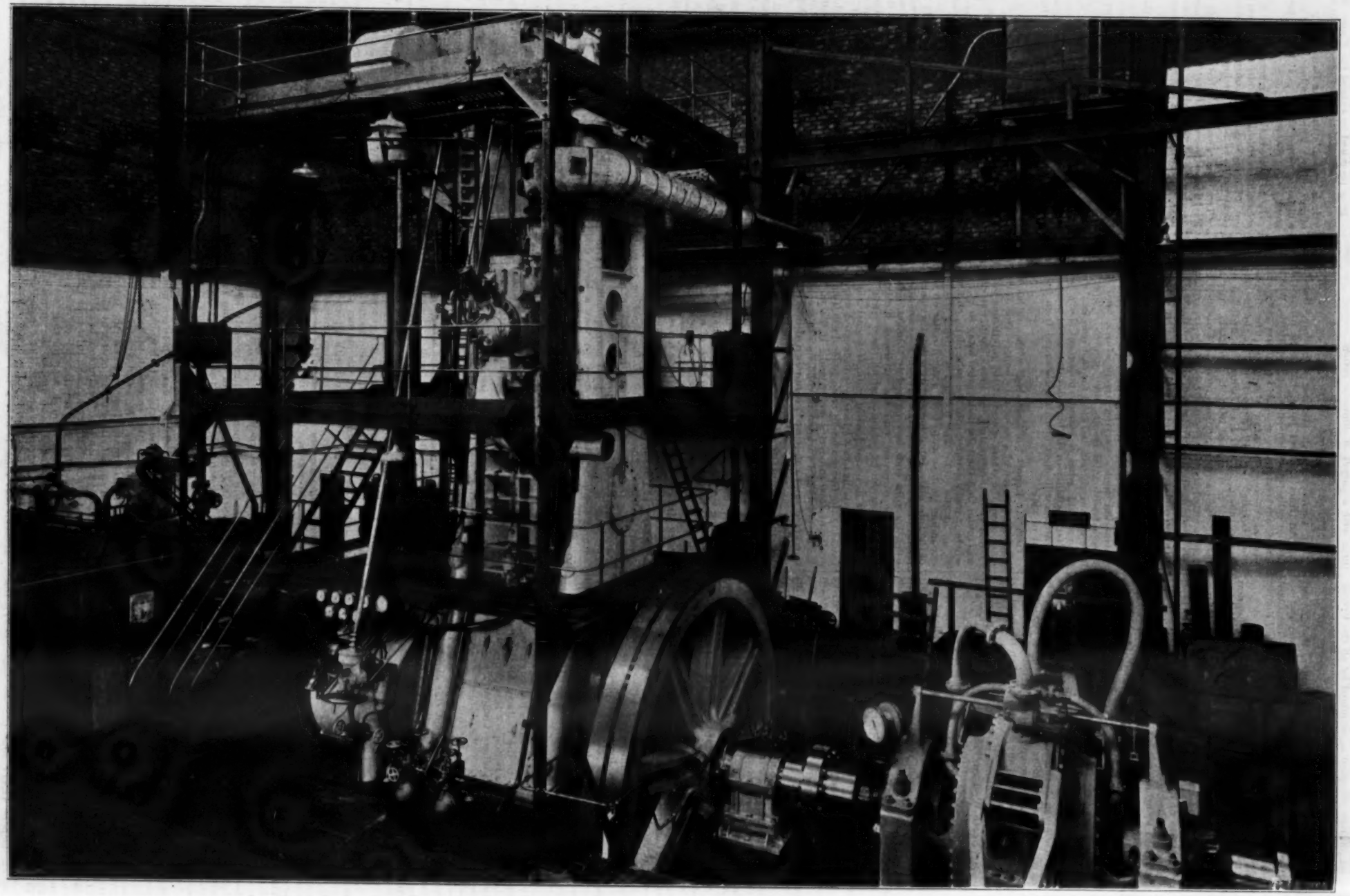
WHEN completed, the hydro-electric development which the Quebec Development Company, Limited, is now undertaking the construction, will be one of the largest of the world. This station is situated on the Saguenay River, about 30 miles up stream of Chicoutimi, Que., and approximately 9 miles below Lake St. John. The exact position of the power-house is at the foot of Isle Maligne, on the left channel of the Grande Decharge, and will occupy the whole channel. The power house, which will contain twelve vertical units of 45,000 horse-power capacity each, will be 700ft. in length.

A COMMUNICATION has been issued by the General Post Office dealing with the experiments which have been conducted on both sides of the Atlantic since 1915, with the object of linking the American and European telephone systems by wireless, which is impracticable with the existing types of submarine cable. Having outlined the earlier steps in this direction, the publication states:—"Transmission of radio telephony has taken place weekly from the Long Island station, which has been received and measured in this country by the Post Office and by the Western Electric Company. In the January, 1923, demonstration a simple loop frame aerial was employed at the receiving end. A special receiving antenna was built by the Post Office, and tests showed that reception on it was more powerful and more free from atmospherics than on older systems. During the winter months, when conditions were favourable, speech was occasionally distributed during the daytime over the land lines to a number of telephone subscribers at their homes in London and other parts of the country. The improvement gained was therefore the possibility of communication during certain hours when there is daylight in both countries, which under the previous reception conditions was in general unsatisfactory."

750 TO 1000 I.H.P. DOUBLE-ACTING MARINE OIL ENGINE

THE NORTH-EASTERN MARINE ENGINEERING COMPANY, LIMITED, WALLSEND-ON-TYNE, ENGINEERS

(*For description see page 626*)



SWISS MAIN LINE RAILWAYS

Railway.	No.	GENERAL. Section.	Date opened for electric working.	Route length. km.	Number of tracks.	Gauge, m.	No. of Intermediate stations.	Mean distance between stations, km.	Maximum Gradient, °/₀₀	Minimum curve rad., m.	Type of rail.	Weight of rails, kgm./ length per rail, m.	Max. allowable axle load, t.	Maximum Allowable speed, km./h.	CONTACT LINE. Current voltage and frequency.	Contact line suspension.	Contact line.
A. BERNESE ALPS RAILWAY* (Berne–Lötschberg–Simplon)	1	Spiez–Frutigen	1910	14	2	1.435	14	6	27	300	Vig.	36/12	18	75	Single-phase, 15,000 v., 16⅔ periods	Compound catenary 5.7 to 6.7 m. above track.	*Main lines :—* Copper contact wire .. 100 mm.² Steel catenary cable .. 50 mm.² Steel auxiliary wire .. 28 mm.²
	2	Frutigen–Brigue	1913	60	1 (2 in Lötschberg tunnel)	1.435					Double-headed	42/12					
	3	Spiez–Scherzligen	1915	10	2	1.435					Vig.	36/12					*Main lines :—* Copper contact wire .. 100 mm.² Steel catenary cable .. 50 mm.²
	4	Spiez–Interlaken–Boenigen	1920	20	1	1.435	5	4	15	240	Vig.	36/12	18	60		Single catenary 5.7 to 6.7 m. above track.	*Main lines :—* Copper contact wire .. 100 mm.² Steel catenary cable .. 50 mm.²
	5	Spiez–Zweisimmen	1920	35	1	1.435	8	4.4	25	200	Vig.	26/12	12.75	50			*Main lines :—* Copper contact wire .. 50 mm.² Steel catenary cable .. 50 mm.²
	6	Berne–Belp–Thun	1920	34	1	1.435	11	3.1	22	180	Vig.	26/12	12.75	50			*Main lines :—* Copper contact wire .. 100 mm.² Steel catenary cable .. 50 mm.²
	7	Berne–Schwarzenburg	1920	21	1	1.435	6	3.5	35	177	Vig.	26/12	12.75	40			*Main lines :—* Copper contact wire .. 50 mm.² Steel catenary cable .. 50 mm.²
B. RHAETIAN RAILWAY†	8	Schuls–Bevers, S. Moritz–Samaden–Pontresina	1913	62	1	1.0	18	3.6	25	160	Vig.	27/12–15	11	45 on grades 0–15 °/₀₀ or curves down to 200 m. radius		Part single and part double catenary, 5.5 to 6 m. above track.	*Main lines and sidings :—* Copper contact wire .. 80 mm.² Catenary cable (steel) .. 40 mm.² (some parts also with an auxiliary steel wire, 28 mm.²)
	9	Bevers–Thusis Filisur–Davos	1919	76	1	1.0	15	2.8	35	100	Vig.	27/12	11	40 on grades 15–25 °/₀₀ or curves down to 160 m. radius	Single-phase, 11,000 v., 16⅔ periods		*Main lines :—* Copper contact wire, 100 or 85 mm.² Steel catenary cable .. 40 mm.² *Secondary lines :—* Copper contact wire, 80 or 70 mm.² Steel catenary cable .. 40 mm.²
	10	Thusis–Landquart, Davos–Klosters	1921	56	1	1.0	32	2.8	45	100	Vig.	27/12	11	35 on grades 25–40 °/₀₀ or curves down to 120 m. radius		Single catenary 5.5 to 5.8 m. above track. (4.1 m. in tunnels).	*Main lines :—* Copper contact wire .. 85 mm.² Steel catenary cable .. 40 mm.² *Secondary lines :—* Copper contact wire .. 70 mm.² Steel catenary cable .. 40 mm.²
	11	Klosters–Landquart, Reichenau–Dissentis	1922	83	1	1.0	23	3.6		100	Vig.	27/12	11	30 on grades 40–50 °/₀₀ or curves down to 90 m. radius			
‡ WISS FEDERAL AILWAYS ‡	12	Scherzligen–Thun–Berne	1918–9	32	2	1.435	9	3.6	10	250	Vig.	45/12	20	90	Single-phase, 15,000 v., 16⅔ periods	Single catenary 5.7 to 6 m. above track.	*Main lines :—* Copper contact wire .. 107 mm.² Iron catenary cable .. 84 mm.² *Sidings :—* Copper contact wire .. 57 mm.² Iron catenary cable .. 50 mm.²
	13	Erstfeld–Biasca (Gothard)	1920	90	2	1.435	12	7.5	27	280	Vig.	45/12 in open 54/12 in tunnel	20	65 on 27 °/₀₀ grades or curves down to 280 m.; Gothard Tunnel, 75; Bellinzona–Biasca, 90		Compound catenary 5.5 to 6 m. above track. Tunnels, simple catenary, 4.8 m. above track.	*Main lines :—* Copper contact wire .. 107 mm.² Iron catenary cable .. 88 mm.² Iron auxiliary wire .. 85 mm.²
	14	Biasca–Chiasso Immensee–Rothkreuz Erstfeld–Lucerne –Zug Goldau–Zurich	1921 1921	215	1 for 125.6 km. 2 for 87.4 km.	1.435	41	5.2	26	300	Vig.	45/12	20			Compound catenary on Biasca-Chiasso and Erstfeld-Lucerne. Others, single catenary.	*Main lines :—* As above, except in stations. In stations on the Goldau–Zurich, Zug–Lucerne, and Immensee–Rothkreuz, same as above, but without auxiliary wire
	15	Sion (Sitten)–Lausanne		92	1 for 12.9 km. 2 for 79.9 km.	1.435	22	4.2	11	500	Vig.	45/12	20			Single catenary 5.5 to 6 m. above track.	*Main lines :—* Copper contact wire .. 107 mm.² Steel catenary cable .. 56 mm.²
WISS EDERAL AILWAYS	16	Brieg–Iselle (Simplon Tunnel)	1906	22	1	1.435	3	11	7	300	Vig.	49/12		75	Three-phase 3000 v., 15 periods	Simple suspension. Normal height 5.0 m.	Double overhead lines, 2 × 50 mm.² per phase. In stations, 1 × 50 mm.² per phase.
ERGDORF HUN AILWAY	17	Burgdorf–Thun	1899	40	1	1.435	16	2.7	25	250	Vig.	36/12	7.5	60	Three-phase 750 v. 40 periods		Double overhead lines, 50 mm.² per phase.
REIBURG-URTEN-S8	18	Freiburg–Murten –Ins	1903	32	1	1.435	10	3.6	30	200	Vig.	33/–			Direct-current, 800 v.	Third rail 135 mm. above running rail level.	Third rail, equivalent to 410 mm.² copper, with 2 × 100 mm.² copper bonds. Overhead line in three main stations.

* *Tunnels :*—Copper contact line, 100 mm.² Catenary cable (steel with copper covering) 57 mm.² *Sidings :*—Copper contact wire, 55 mm.² Catenary cable (steel), 50 mm.²

ELECTRIFICATION.—TABLE X.

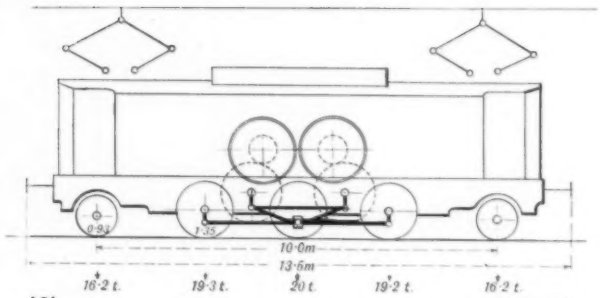
CONTACT LINE.			POWER SUPPLY.						
Description and spacing of supports, m.	Insulation.	Return.	No. of feeding points.	Feeding points.	Mean length of line per feeding point, km.	Equipment of feeding points.	Feeding lines (sub-stations along tracks).	Transmission lines (sub-stations to power station).	Power Stations.
Iron lattice poles and yokes with concrete base. 60	Double	Rails, connected to feeding points 50 mm.² copper. Bonding by riveted copper.	3	Direct feeding at 15,000 v. from the hydro-electric stations at Spiez, Kandergrund and Mühleberg	42	See power station	Along all main lines, a feeding wire of 50 mm.² copper or 100 mm.² aluminium, on same supports as the contact line, and connected at some of the stations (on the Lötschberg Railway, at all stations). Kandergrund is connected to the contact wire by air line 1.6 km., comprising 4 copper wires 50 mm.². Earth return. Spiez & Mühleberg connected by 2 aluminium wires 100 mm.².	None	*Spiez :* (hydro-electric) Storage, 280,000 m.³ Head, 64 m. 2 turbines, 2400 kw., 300 r.p.m. 2 single-phase generators, 2500 kVA, 15,000 v., 16⅔ periods.
	Double								
	Double								
Wooden poles with iron arms or yokes in the open; iron lattice poles in the stations. Concrete base. 60	Single				20				*Kandergrund :* (hydro-electric) Storage —none. Head, 298 m. 3 turbines, 2400 kw., 300 r.p.m. 3 single-phase generators, 2700 kVA, 15,000 v., 16⅔ periods.
	Single				35				
	Single								*Mühleberg :* (hydro-electric) Storage, 10 million m.³ Head, 29 m. 2 converter groups, each comprising: 1 three-phase motor, 5000 kVA, 500 r.p.m.; 1 single-phase generator, 5000 kVA, 15–16,000 v., 16⅔ periods.
	Single								
Iron lattice poles with concrete base. 60	Double	Rails, connected at feeding points with 50 mm.² copper. Bonding (various types) copper or round iron 6 mm. diam.	3	Indirect feeding at 10,000–11,000 v. by converter sub-station at Bevers, fed from the Brusio power station; also direct feeding from power stations at Thusis and Kublis	62	See power stations	Along all the main lines, a feed wire of 50 mm.² copper, on same supports as the contact line. In tunnels, the feed wire is replaced by a copper cable 95 mm.² beside the track, or by air line of 50 mm.² on wood poles, feeding each end, and passing over the mountains.	Bevers is fed with 3-phase power from Brusio by two independent air lines at 23,000 v., each 3 × 28 mm.² copper wires on wood poles. Mean span 40 m. Special protection against avalanches.	*Bevers :* (converter station) 2 three-phase transformers, 23,000/500 v., 1050 kVA. 2 converter groups each comprising: 1 three-phase motor, 900 H.P., 500 v., 50 periods, 450–540 r.p.m.; 1 single-phase generator, 1300 kVA, 2500 v., 15–17 periods; 1 D.C. motor generator set. 2 single-phase transformers, 2500/11,000 v., 1800 kVA. 2 batteries, 1250 Ah each. *Thusis :* (hydro-electric) Storage, 650 m.³ Head, 91 m. 2 turbines. 2 single-phase generators, 2000 kVA, 11,000 v. *Kublis :* (hydro-electric) Storage, 30,000 m.³ Head, 330 m. 1 turbine. 1 single-phase generator, 3600 kVA. 1 single-to-three-phase converter, 3600 kVA
In all stations having a minimum of three tracks; iron lattice poles. In all other places wood poles with iron brackets or yokes. 60					72				
Wood poles, iron yokes or brackets. 60	Single	Rails, connected a. feeding points by 2 copper cables 107 mm.² or by 2 copper wires 28 mm.² (for milking transformers).	4	Feeding from Spiez, Kandergrund and Mühleberg power stations at 15,000 v. to automatic sub-stations, where transformed to ± 15,000 v. for a special 3-wire system. The sub-stations are at Thun, Kiesen, Rubigen and Ostermundigen	8 (32)	Transformers of 2000 kVA. Three at Thun, and one at each other point	Thun fed from Spiez by 2 air lines, 100 mm.² aluminium. Rail return.	None	*Spiez :* (hydro-electric). *See above.* *Ritom :* (hydro-electric) Storage, 26 million m.³ Head, 800 m. 4 turbines, 9000 kw., 333 r.p.m. 4 single-phase generators, 9000 kVA., 15,000 v., 16⅔ periods. 4 transformers, 8500 kVA.
Iron lattice poles. 56–60	Double. Single in tunnels	Rails, connected at feeding points by 2 copper cables 107 mm.²	3	Direct feeding at 15,000 v. from Ritom power station, and indirect by transformer sub-stations at Göschenen and Giornico, fed from Ritom at 60,000 v.	30	Two transformers of 5000 kVA in each sub-station	No feeding lines along double tracks. Along single tracks, a copper line, 100 mm.², on same supports as contact line. Earth return.	Sub-stations connected to Ritom and Amsteg by overhead wires or buried cables at 60,000 v.	*Amsteg :* (hydro-electric) Storage, 200,000 m.³ Head, 258 m.
Iron lattice poles.	Double on Biasca-Chiasso and Erstfeld-Lucerne; others single, except where steam traction still exists	Rails.	5	Direct feeding at 15,000 v. from Ritom and Amsteg, and indirect by transformer sub-stations at Giubasco, Melide, Steinen and Sihlbrugg, fed from Ritom and Amsteg at 60,000 v.					*Barberine :* (hydro-electric) Storage, 41 million m.³ Head, 700 m. 3 turbines, 11,500 kw., 333 r.p.m. 3 single-phase generators, 10,000 kVA., 15,000 v., 16⅔ periods.
Iron lattice poles. 100	Single	Rails.	2	Indirect feeding by sub-stations at Vernayaz and Puidoux, fed from Barberine power station at 66,000 v.	46			Sub-stations connected to Barberine by overhead line at 66,000 v.	
Suspended from cross wires (steel covered with copper).	Double	Rails copper-bonded.	2	Direct feeding by power stations at Massaboden and Isello	11				*Massaboden :* } (hydro-electric) *Isello :* } Each 1000 kw., three-phase, 3000 v., 15 periods.
	Double	Rails copper-bonded.	14	Indirect feeding by transformer sub-stations, fed from the power station at Spiez	3	Transformer stations of 200 kw.		3-ph. transmission line, 16,000 v., 40 periods.	*Spiez :* (hydro-electric) *See above.*
	—	Running rails.	2	Indirect feeding by converter sub-stations, fed from Hauterive power station of the Freiburg Canton	16	Each two 3-ph.-D.C. converters, 135 kw. Also battery of 400 cells, 390 amp-h		3-ph. transmission line, 8000 v. 50 periods.	*Hauterive :* (hydro-electric) Traction load about 1000 H.P.

† *Tunnels* :—1 catenary wire (copper) 64 mm.²

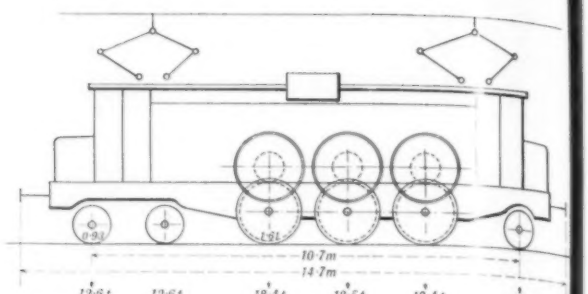
‡ *Tunnels* :—2 twin copper contact wires, 2 × 107 mm.² Catenary cable (steel with copper covering), 56 mm.²

NOTE TO BINDER.—Bind by left-hand edge.

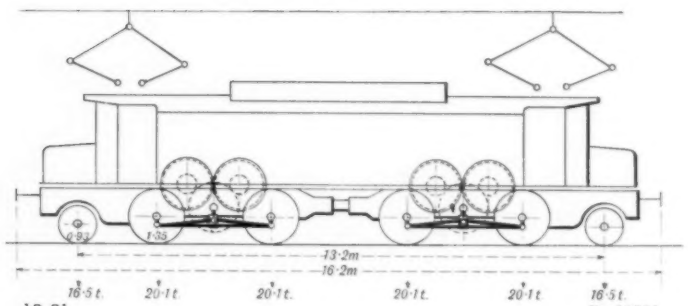
SWISS FEDERAL RAILWAYS
SINGLE PHASE ELECTRIC LOCOMOTIVES



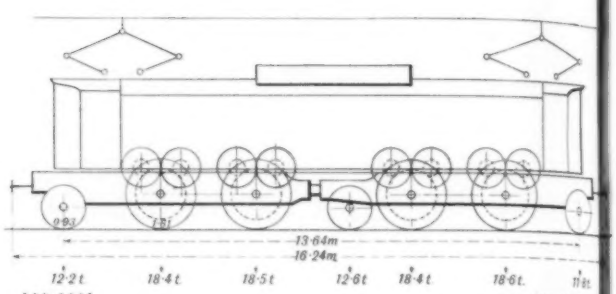
1C1 — No. 11201



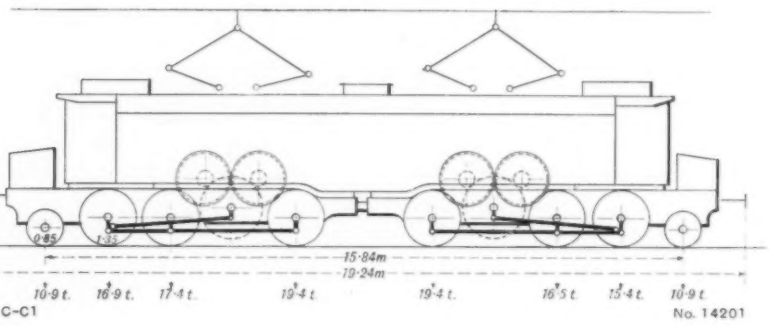
2AAA1 — Nos. 10301-26



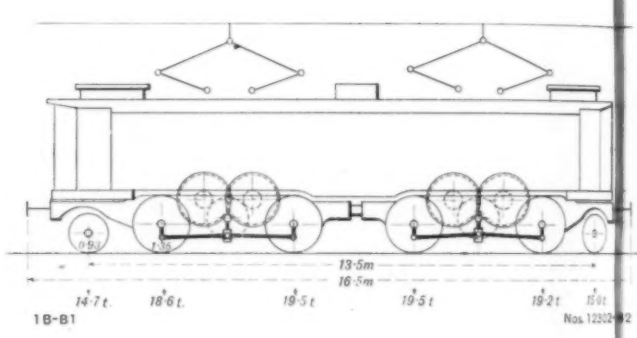
1B-B1 — No. 12301



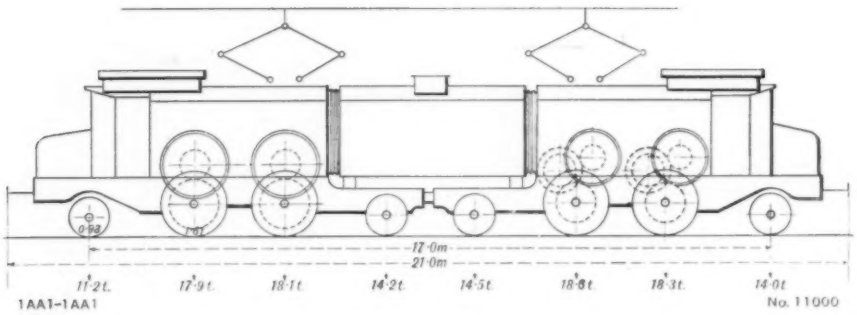
1AA-1AA1 — Nos. 12501-



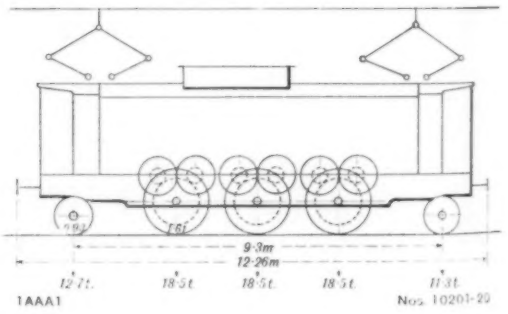
1C-C1 — No. 14201



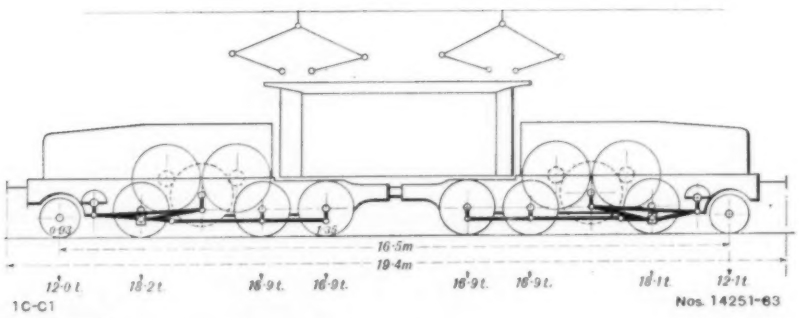
1B-B1 — Nos. 12202-92



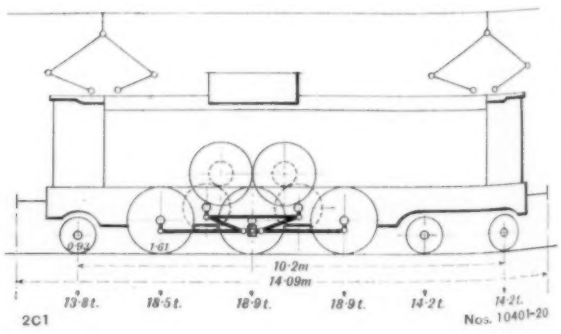
1AA1-1AA1 — No. 11000



1AAA1 — Nos. 10201-29



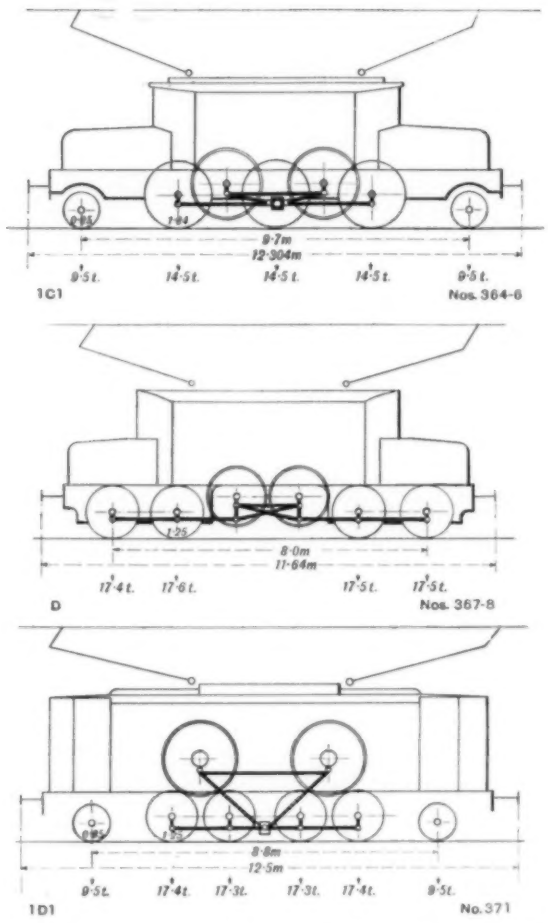
1C-C1 — Nos. 14251-63



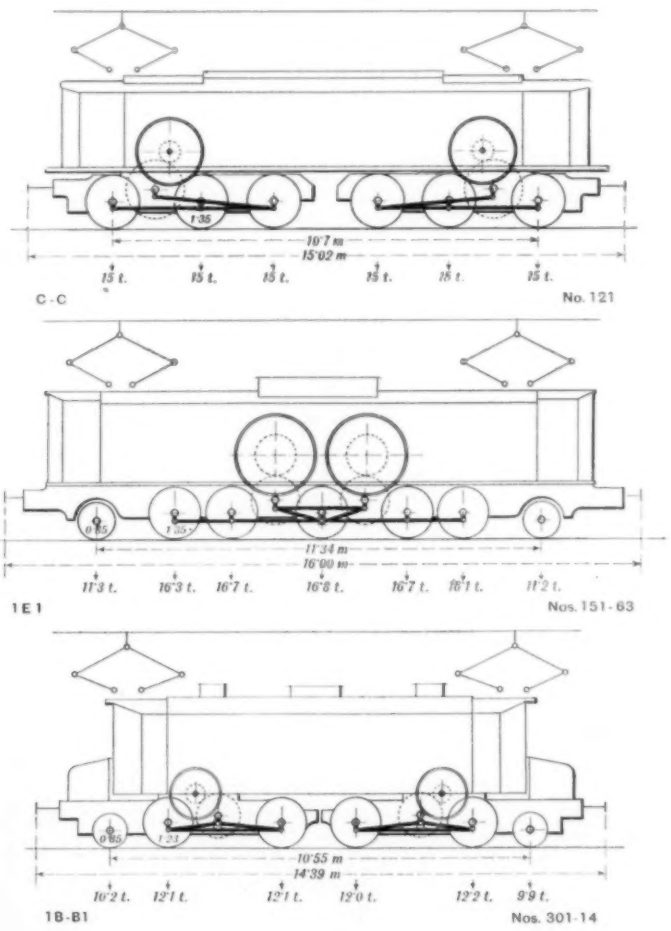
2C1 — Nos. 10401-20

ELECTRIC LOCOMOTIVE TYPES

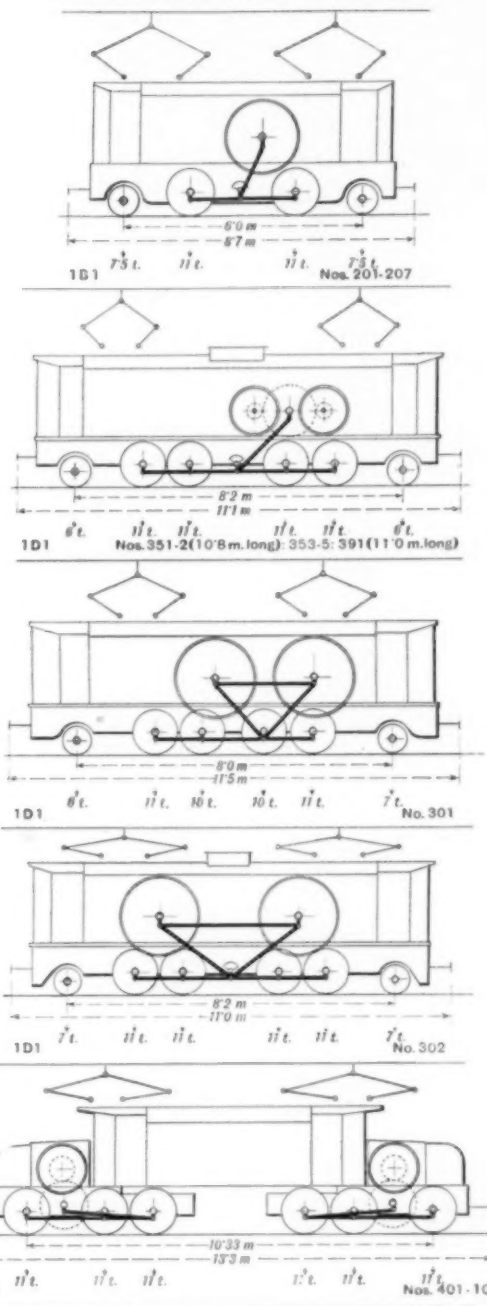
SIMPLON RAILWAY
3 PHASE ELECTRIC LOCOMOTIVES



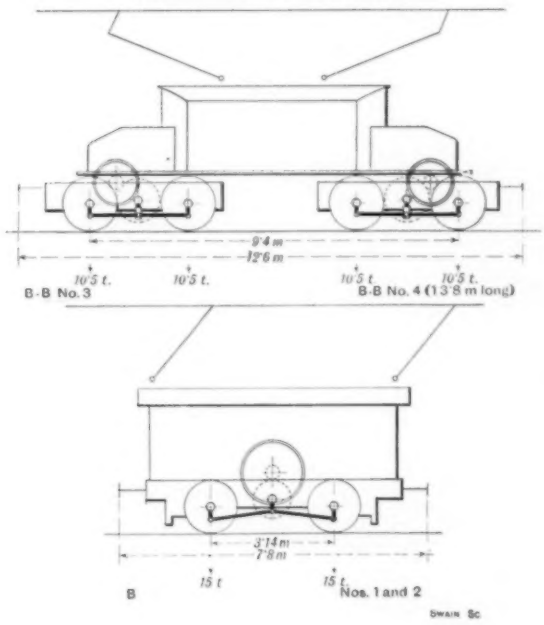
LOETSCHBERG RAILWAY
SINGLE PHASE ELECTRIC LOCOMOTIVES



RHAETIAN RAILWAY
SINGLE PHASE ELECTRIC LOCOMOTIVES



BURGDORF THUN RLY.
3 PHASE ELECTRIC LOCOMOTIVES



DWAIN Sc

AGENTS ABROAD FOR THE SALE OF

The Engineer

BUENOS AIRES.—MITCHELL'S BOOK STORE, 576, Cangallo.
CHINA.—KELLY AND WALSH, Limited, Shanghai and Hong Kong.
EGYPT.—CAIRO EXPRESS AGENCY, near Shepheard's Hotel, Cairo.
FRANCE.—BOYVEAU AND CHEVILLET, Rue de la Banque, Paris.
CHAPELOT AND CIE., 136, Bld. St. Germain, Paris.
BELGIUM.—W. H. SMITH AND SON, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.
INDIA.—A. I. COMBRIDGE AND CO., Bombay; THACKER AND CO., Limited, Bombay; THACKER, SPINK AND CO., Calcutta.
ITALY.—MAGLIONI AND STRINI, 307, Corso, Rome; FRATELLI TREVES, Corso Umberto 1, 174, Rome; FRATELLI BOCCA, Rome; ULRICO HOEPLI, Milan.
JAPAN.—MARUZEN CO., Tokyo and Yokohama.
AFRICA.—WM. DAWSON AND SONS, Limited, 7, Sea-street (Box 49), Capetown.
C. JUTA AND CO., Johannesburg, East London, and Grahamstown.
AUSTRALIA.—GORDON AND GOTCH, Limited, Melbourne, Sydney, Brisbane and Perth, &c.
MELVILLE AND MULLEN, Melbourne.
ATKINSON AND CO., Gresham-street, Adelaide.
CANADA.—DAWSON, WM., AND SONS, Limited, 87, Queen-street East, Toronto.
GORDON AND GOTCH, Limited, 132, Bay-street, Toronto.
MONTREAL NEWS CO., 386–388, St. James-street, Montreal.
TORONTO NEWS CO., 42, Yonge-street, Toronto.
CEYLON.—WIJAYARTNA AND CO., Colombo.
JAMAICA.—EDUCATIONAL SUPPLY CO., Kingston.
NEW ZEALAND.—GORDON AND GOTCH, Limited, Wellington and Christchurch; UPTON AND CO., Auckland; J. WILSON CRAIG AND CO., Napier.
STRAITS SETTLEMENTS.—KELLY AND WALSH, Limited, Singapore.
UNITED STATES OF AMERICA.—INTERNATIONAL NEWS CO., 83 and 85, Duane-street, New York; SUBSCRIPTION NEWS CO., Chicago.

Agents Abroad for Advertisements.

UNITED STATES OF AMERICA.—BRITISH AND COLONIAL PRESS, Inc., 161, East Erie-street, Chicago, Ill.
FRANCE.—AGENCE VOX, 7, Rue de Surène, Paris (VIIIe).
BELGIUM.—W. H. SMITH AND SON, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.

SUBSCRIPTIONS.

THE ENGINEER can be had, by order, from any newsagent in town or country, at the various railway stations; or it can, if preferred, be supplied direct from this office.

Half-yearly (including index number) .. £1 12s. 6d.
Yearly (including two index numbers) .. £3 5s. 0d.

If credit occur, an extra charge of two shillings and sixpence per annum will be made.

Foreign Subscriptions will be received at the rates given below. Foreign subscribers paying in advance at these rates will receive THE ENGINEER weekly and post free. Subscriptions sent by Post Office Order must be made payable to THE ENGINEER and accompanied by letter of advice to the Publisher.

THIN PAPER COPIES.		THICK PAPER COPIES.	
Half-yearly	£1 11s. 6d.	Half-yearly	£1 13s. 9d.
Yearly	£3 3s. 6d.	Yearly	£3 7s. 6d.

(The difference to cover extra postage.)

Canadian Subscriptions—
Thin paper edition .. .. £2 19s. 6d. per annum.
Thick paper edition .. .. £3 3s. 0d. „

*** READING CASES, *to hold two copies of* THE ENGINEER, *cloth sides and leather backs, can now be supplied at 4s. 9d. each, 5s. 3d. post free.*

ADVERTISEMENTS.

*** The charge for Situations Open and Wanted Advertisements of four lines and under is four shillings, and one shilling per line for each additional line up to one inch. When an advertisement measures an inch or more the charge is twelve shillings per inch. The rates for all other classes of advertisements, other than those mentioned above, are included in "THE ENGINEER Directory," which is sent post free on application. All single advertisements from the country must be accompanied by a remittance in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.

Small Advertisements cannot be inserted unless delivered before TWO o'clock on Thursday afternoon (the day before publication). ALTERATIONS to STANDING ADVERTISEMENTS must arrive not later than THURSDAY of the week preceding publication.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters to be addressed to the Editor of THE ENGINEER.

THE ENGINEER DIRECTORY.

This Directory, which is published annually in the interests of advertisers in THE ENGINEER, may be obtained free of charge on application to the Publisher.

Postal Address, 35, Norfolk-street, Strand, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Telephone Nos. 2256, 2257 Central.

PUBLISHER'S NOTICES.

*** *With this week's number are issued two Two-page Supplements relating to the Electrification of the Swiss Main Line Railways. Every number, as issued by the Publisher, contains a copy of these Supplements, and Subscribers are requested to notify the fact should they not receive them.*

*** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

TO CORRESPONDENTS.

*** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

Contents.

THE ENGINEER, June 6th, 1924.

	PAGE
A SEVEN-DAY JOURNAL	617
THE BRITISH EMPIRE EXHIBITION.—No. VII. (Illus.)	618
OBITUARY—	
L. Sterne	624
EMPIRE MINING AND METALLURGY.—No. I.	624
EFFECT OF DEEP-WATER QUAYS ON NAVIGATION	625
THE NORTH-EASTERN WERKSPOOR DOUBLE-ACTING MARINE OIL ENGINE.—No. II. (Illus.)	626
THE MOTOR SHIP DOLIUS. (Illus.)	627
INSTITUTION OF NAVAL ARCHITECTS	628
LONDON-BRISTOL TELEPHONE CABLE	628
LETTERS TO THE EDITOR—	
Fluid Friction	628
The First Uni-flow Engine	628
The First Continuous Automatic Railway Brake	628
Labour Government Organisation of Labour	628
Capital and Labour	628
RAILWAY MATTERS	629
NOTES AND MEMORANDA	629
MISCELLANEA	629
LEADING ARTICLES—	
American Naval Policy	631
The Brinell Test	632
SIXTY YEARS AGO	632
BOOKS RECEIVED	632
MAIN LINE RAILWAY ELECTRIFICATION. (Illus.)	633
AN EFFICIENT PRIMARY CELL. (Illus.)	636
BRITISH WATERWORKS: CHEDDAR SUPPLY. (Illus.)	637
ATOMS AND ISOTOPES	637
THERMIONIC VALVE RECTIFIERS. (Illus.)	638
PROVINCIAL LETTERS—	
The Midlands and Staffordshire	639
Lancashire	639
Sheffield	640
North of England	640
Scotland	641
Wales and Adjoining Counties	641
CURRENT PRICES FOR METALS AND FUELS	642
FRENCH ENGINEERING NOTES	643
BRITISH PATENT SPECIFICATIONS. (Illus.)	643
FORTHCOMING ENGAGEMENTS	644
PERSONAL AND BUSINESS ANNOUNCEMENTS	644
CONTRACTS	644
PARAGRAPHS—	
Kelvin Centenary Celebrations	638
The Institute of Physics	644
The Institution of Automobile Engineers	644

TWO TWO-PAGE SUPPLEMENTS—ELECTRIFICATION OF THE SWISS MAIN LINE RAILWAYS.

THE ENGINEER.

JUNE 6, 1924.

American Naval Policy.

THE recent adoption by Congress of a new ship-building programme is apparently the result of an agitation for naval preparedness which the major part of the American Press has been conducting for well over a year. During this period there have been countless "revelations" of a more or less sensational character, tending to show that the United States Navy is lacking in all the elements making for war efficiency. Its relative strength in capital ships is governed by the Limitation Treaty, but although the specified number of these craft is available, few of them, it is claimed, are in a fit condition to engage in modern operations of war. They are said to be inferior to contemporary British and Japanese units in respect of gun range, protection and speed. As long ago as December, 1922, Congress appropriated a large sum of money for increasing the elevation of the turret guns in thirteen battleships. This money was voted on the strength of reports which declared that the British Admiralty had undertaken similar improvements in its battleships since the war. As a matter of fact, no such change had been made in this country, and, following a disclaimer by the British Embassy in Washington, Congress ordered the gun-elevation vote to remain in abeyance. A fortnight ago the question arose once more, but Congress refused to sanction the commencement of the work, on the ground that any change in the artillery equipment of the battleships would constitute an infringement of the Washington Treaty. On this point there is room for an honest difference of opinion, for the wording of the Treaty is somewhat vague. Dealing with the reconstruction of capital ships, it says: "No alterations in side armour, in calibre, number or general type of mounting of main armament shall be permitted . . ." The question is, Would an increase in the maximum elevation of turret guns from 15 deg. to 25 deg. or 30 deg. represent a change in the "general type of mounting"? American naval officers insist that it would not, while Congress takes the opposite view. The British naval authorities, we understand, have never been asked to give an official opinion on the subject, nor have they ever sought to influence the decision. The position to-day is that of the eighteen battleships comprising the American post-Treaty fleet, thirteen have a gun elevation of 15 deg., equivalent to an extreme range of 20,000 to 22,000 yards, while the remaining five, with mountings permitting an elevation of 30 deg., can range up to 32,000 yards. Of the twenty-two British capital ships, only the Hood is fitted with high-angle mountings, which give her 15in. guns a range of 30,100 yards. In our remaining twenty-one ships the gun mountings are designed for an elevation of 20 deg., enabling them to use their main armament at an extreme range of 23,000 to 24,000 yards. While therefore the American Fleet has a decided advantage at any distance above 24,000 yards, it would be inferior in volume of fire if an engagement developed at ranges varying from 22,500 to 24,000 yards. To us the difference does not seem of vast importance, though there is, no doubt, some weight in the American contention that the British Fleet, with its higher collective speed, would be in a position to open and maintain the action at a range most advantageous to itself. These discussions do not necessarily imply a belief in either country that the two fleets will ever meet in battle. They are purely technical, and attempts to invest them with political significance cannot be too strongly deprecated.

Next to this matter of gun elevation, the indifferent steaming performance of their older battleships has been causing American naval authorities the gravest concern. In the recent manœuvres off Panama and in the Caribbean Sea, the pressure of steam in the boilers of the Wyoming, Arkansas, Florida and Utah had to be limited to 160 lb., with the result that the maximum speed fell to about 14 knots, and difficulties in the operation of the auxiliary machinery arose. The ships named are primarily coal burners, as also are the New York and the Texas. Congress, it is now reported, has authorised the conversion of all six ships to oil fuel, a change that will augment both their speed and cruising radius. Our own post-Treaty Fleet contains nine coal-burning ships—the four "Iron Dukes," the three "King George V." class, Thunderer and Tiger—and it remains to be seen whether the Admiralty will recommend the conversion of some or all of these ships to oil fuel, now that the United States has led the way. In addition, the older American battleships are to be fitted with special armour and protection against plunging gunfire and torpedo attack, this improvement being expressly allowed for in the Limitation Treaty, provided the increase of displacement does not exceed 3000 tons. Owing to shortage of funds, work on the two big American aircraft carriers, Lexington and Saratoga, proceeds so slowly that it will be several years before they are ready to hoist the pennant. Meanwhile, the only carrier available is the ex-collier Langley, which is too slow and of too primitive a design to give satisfaction. Such fine aeroplane tenders as the Eagle, the Hermes and the Argus have as yet no counterpart in the United States Navy. The serious dearth of cruisers is to be remedied by the construction of eight 10,000-ton ships, armed with 8in. guns, which are to be built at an estimated cost of £3,000,000 each. This seems a prodigious price for ships of the cruising class. Our new "County" class, of the same displacement, are expected to cost £2,000,000 apiece. Evidently, therefore, British shipbuilders are still able to turn out men-of-war more cheaply than the American yards. In every list of comparative naval strength emanating from Washington, the British Empire is credited with about fifty-five cruisers, the United States with ten, and Japan with twenty-five. These figures, however, are rather deceptive, since the majority of our cruisers are of too small a displacement to be suitable for ocean work. Furthermore, with the exception of the cruiser-minelayer Adventure and the five ships to be built under the current Estimates, all these vessels ante-date the Armistice, which means that their design does not fully embody war experience or the latest technical developments in structure, machinery and equipment. On the other hand, the ten American units are ocean-going ships of 7500 tons, and of post-war construction, while twenty-three of the Japanese cruisers were laid down after the signing of peace. We have at present only six cruisers with a displacement above 7000 tons, and are therefore well below our ratio in cruising ships of the ocean-going type. Nor will the position be much improved when the five new "Counties" are in service, for by that time, or a little later, the completion of America's eight 10,000-ton vessels will have brought her strength in the ocean-going type up to eighteen units. To the British Empire, with its extensive and exposed sea communications, on the maintenance of which its very existence depends, an adequate force of cruising ships is quite indispensable. The Admiralty's plan for the replacement of our fifty ageing cruisers in the next ten years is exceedingly moderate, considering the enormous demand for such vessels that would arise at the first hint of menace to our seaborne trade. In submarines this country is already out-

distanced by the United States and Japan. Built and building we have approximately sixty boats, the United States has one hundred and twenty, and Japan seventy-seven. Despite these figures, however, American critics are by no means satisfied with the position. They consider their submarines to be inferior to the latest foreign models in speed, radius and general design. It was stated in Congress two months ago that the three largest boats, T 1 to T 3, were at that time "tied up at Hampton Roads on account of defective machinery." Very adverse reports have also been published respecting the "S" class, a series of fifty boats displacing from 800 to 990 tons. In his official report of the winter manœuvres, Admiral R. E. Coontz, commanding the United States Fleet, wrote as follows: "Of the combatant ships taking part in the problems, the submarines are the worst. Their design is obsolete and faulty. Their ventilation is poor, and, at times, almost non-existent. The temperatures in the engine-rooms rose as high as 135 deg. They are unreliable. Some of their oil tanks leak, either spoiling their fresh water or enhancing the fire menace, or leaving an oil 'slick' whereby they can be traced. The radius of the Holland boats is much less than rated, and they drag excessively when loaded. All the submarines are so deficient in speed as to be of small use for fleet work except by accident of position." Coming from such a source, this is a very serious indictment; nor are the Admiral's criticisms of material confined to the submarine branch.

In consequence of these and other official strictures on the state of the American Navy, public opinion in that country is now paying to the whole question of naval preparedness an attention which has become particularly marked since the dispute with Japan on the immigration issue entered upon its present somewhat delicate stage. Disappointment is freely expressed at the failure of the Washington Treaty, not only to stabilise the international naval situation, but even to arrest that rivalry in shipbuilding programmes which statesmen and economists recognise as being one of the most fruitful causes of war. We in this country could not remain indifferent spectators of a competition between the United States and Japan for supremacy in those implements of naval warfare, such as cruisers and submarines, which may be destined to exercise an overmastering influence on any future struggle for the command of the sea. Our policy of new construction, as laid down by the late Government and approved, in principle, by the present Administration, is based on the assumption that the *status quo* in relative naval strength would be maintained for a great many years to come. Should this anticipation be falsified by competitive building in other quarters, it will become necessary to review the position and adjust our own programme to meet the new conditions. Our allotment of sea power, compared with that of other nations, now stands at the absolute minimum consistent with security. We cannot—nay, we dare not—make any further sacrifice at the expense of the Navy, which still remains for us the first line of defence and the strongest of all the bonds that hold the British Empire together.

The Brinell Test.

THE desirability or even necessity of some simple test that shall serve as a measure of the "hardness" of metals is fully recognised by engineers and metallurgists; so also is the very great difficulty of devising such a test. The attempts have been many, and the majority have failed in at least two respects—the test itself has been either of too elaborate a nature or too uncertain in its indications to serve for routine testing purposes, and the thing really measured has been too ill-defined a property or group of properties of the material under test. These difficulties arise from the fundamental fact that the property of hardness is itself difficult to define in any satisfactory way. From these circumstances, a position which is in many ways anomalous, has been reached. Broadly speaking, two hardness tests have secured widespread adoption. One may be termed the "static indentation" test, in which an indentation is made in the test piece by a hard object of standard shape, such as a ball or cone, and the hardness is estimated in terms of the ratio of the amount of such indentation to the load employed. The other also produces a small indentation, but it is made by the impact of a falling body having a hard point, and the hardness is estimated in terms of the rebound of the falling body. The Brinell ball test and the Shore scleroscope are, of course, the best-known of these types of test. Fortunately, the rate at which a small indentation is made does not, in metals which are closely similar to one another, make much difference to the result. Accordingly, since the work absorbed from the falling body in tests of the "scleroscope" type is roughly proportional to the size of the indentation, the height of rebound is found to bear a fairly regular relation to the indications of a static ball impression. This correlation of these two types of tests is, however, liable to be misunderstood, and to suggest that both possess a deeper significance than can justly be attached to them.

As a result of the development of two types of test, yielding more or less mutually concordant results for hardness, and also because both these tests are of a simple practical nature eminently suited for routine use, they have become to a large extent "standardised" in practice. They have thus acquired, or are tending to acquire, an authority and significance far greater than their intrinsic merit would justify. Actually, the term hardness itself is coming to be defined not upon any really rational understanding of what is involved in that property, but in terms of the Brinell number. This view of matters, and the consequences to which it is likely to lead, made itself felt recently in a discussion on a paper dealing with the ball-impression test which was presented by Professor Honda to the Iron and Steel Institute, when it was proposed that since the Brinell test, as ordinarily made, had proved so useful and was so universally employed it should not be tampered with. We can fully understand the attitude of those who support that plea. Here is a simple practical test which gives useful information and which is widely used and understood. If it is upset, a new order of standards for hardness must be introduced and inconvenience is inevitable. That is a point of view which is frequently taken up in connection with standardisation, and especially unduly early standardisation, when a thing that is not thoroughly known and understood is applied to practical use for sound reasons of convenience and utility. In all such cases when the time comes for a deeper knowledge of the thing in question, and when the application of advances and improvements becomes desirable, the old-established standard rises up as an obstacle to progress, and has to be overcome by its own more scientific descendants. Were it not for the highly developed mechanism for periodical revision, we should find our standard specifications occupying a similarly obstructive position. As it is, such obstructive tendencies can be overcome step by step before they become prohibitively difficult. In regard to hardness testing, however, the appeal to which we have referred was launched not against any revolutionary proposal to displace the Brinell test by something different, but almost as a protest against a discussion on the fundamental factors which govern indentation methods of testing. The mere possibility that changes in methods of hardness testing might result immediately led to opposition of this kind. Now, the question may fairly be asked in what respects it is considered necessary to secure improvement on the Brinell test? That it is convenient and useful is admitted, and it may ultimately prove to be as good a test from the practical point of view so to remain a permanent feature of our testing stations. On the other hand, it cannot be regarded as a finally satisfactory test for "hardness," at all events in its present form. It is true that in one sense it is no more "empirical" than other mechanical tests, such as the tensile test, but it differs from these in the fact that the Brinell number depends upon a combination of properties which, so far, it has not yet proved possible to analyse out into fundamental physical properties. We have not only the actual resistance of the metal under test to flow under the pressure of the ball; the metal in the immediate vicinity of the indentation is appreciably work-hardened, and the depth of the indentation depends upon the rate at which the resistance of the metal to further flow increases during the test. Consequently, the Brinell number is not independent of the size of the ball or the load employed, and in some metals even the rate of application of the load exerts an influence. Next, there is the difficulty that the size of the impression is not accurately determinable owing—in softer metals—to the ridge which is formed at the edges of the impression. If the attempt is made to base the hardness number on the actual area of metal in contact with the ball carrying a known load, the difficulty is met that some assumption must be made as to the pressure between ball and metal being normal to their surface of contact. Since the surfaces of ball and test piece are not free from friction, this pressure cannot be normal. Finally, there is the elastic deformability of the ball itself and its effect on the impression—a point to which Professor Honda paid some attention.

Whether it is possible to overcome these difficulties and objections and to arrive at a more satisfactory test of a reasonably simple character, yet remains to be seen. Investigation of the subject and discussion upon it, however, is most certainly required, and should not be in the least discouraged by those who find the present "standard" Brinell test very satisfactory in practice. There is no prospect that the existing tests will be suddenly discarded, and there is, as far as we can see, no probability that manufacturers who now rely on the universal character of the Brinell test will find themselves inconvenienced. To some extent we are still far from knowing what hardness really is, and until we have that knowledge we can only make use of conventional methods of testing. But at the same time, it is unquestionably desirable that scientific inquiry should proceed, and if there is any chance that by some suitable modification an existing test, like the Brinell, may be caused to give results less empirical than those it is now suspected of giving, manufacturers should offer it a cordial welcome.

SIXTY YEARS AGO.

IN our issue of June 3rd, 1864, we published a summary of a paper entitled "The Locomotive in War," which had been read before the Royal United Service Institution by Captain Tyler, the Board of Trade's Railway Inspector. In the Crimean War a railway laid across a sea of mud from the camp to Balaklava enabled us to hold our ground before Sebastopol, but it was in the Italian War of 1859 that the value of the railway for military purposes was first illustrated, so we find it recorded, in a striking and conclusive manner. The French employed railways in that campaign for the transport of their troops in a way that bewildered the Austrians until, as at the battle of Magenta, they themselves learned how to take advantage of railway transport and railway works. The American Civil War was providing still stronger proof of the military importance of railways. In the South the Confederates, it was stated, could never have made headway against the overwhelming forces of the North without the aid of railways. Indeed, the lack of iron to replace the worn lines of their railways was a more serious disadvantage to the Confederates than was the lack of gold to the Federals. On one occasion Lee employed nearly the whole of his army for a couple of days on the breaking up of the Orange Railroad, a feat which the Federals were driven to confess had secured to the rebels an end fully commensurate with the labour and risks involved. If the strategical value now assigned to railways was in those days becoming understood, it was certainly associated with tactical uses which to-day seem curious. Thus it is recorded that John Morgan, a Southern guerilla leader, on one occasion stopped a train on the Nashville line, and covering the engine with tow steeped in turpentine and other inflammable materials, sent it at full speed towards the Federal position "blazing like a comet dire." On another occasion a Confederate engine, which appeared on the scene when a Federal advance was in progress, was chased by the Northern cavalry for a distance of ten miles. The practical lesson drawn from Captain Tyler's lecture was that the army ought to be expressly trained in the construction, repair and destruction of railway works, and perhaps, in the future, even in the working of locomotive engines. An opinion expressed during the discussion on the lecture that in the laying out of new lines their strategical use should always be kept in view, was characterised as "rather visionary," but approval was given to the suggestion that third-class carriages should, as on the French and German lines, be provided with a few pegs on which soldiers—particularly the volunteers—might hang their equipment. It may be added that in the remaining nine months during which the American Civil War continued, the military use of railways was demonstrated in a more emphatic manner than by any instance mentioned in Captain Tyler's lecture, two notable examples being provided by Sherman's march through Georgia to the sea and Grant's final operations, which led to the surrender of Lee and Johnston.

BOOKS RECEIVED.

Democracy and Labour. By F. J. C. Hearnshaw, LL.D. London: MacMillan and Co., Limited, St. Martin's-street, W.C. 2. Price 18s. 6d. net.

The "Electrician" Annual Tables of Electricity Undertakings, 1924. London: Benn Bros, Limited, 8, Bouverie-street, E.C. 4. Price 10s. net.

Payne's Carriage of Goods by Sea. Second edition. By Roger S. Bacon. London: Butterworth and Co., Bell-yard, Temple Bar, W.C. 2. Price 8s. 6d. net.

Notes on the "Standard Dimensions" of Indian Railways. By G. Richards and J. H. White. India: Government Printing Office, 6, Hastings-street, Calcutta.

Gas Engineer's Compendium: A Collection of Statistics, Formulæ, Rules and Data. Compiled by Experts. London: Ernest Benn, Limited, 8, Bouverie-street, E.C. 4. Price 32s. 6d. net.

Saw Mills: Their Arrangement and Management and the Economical Conversion of Timber. Sixth edition, revised and enlarged. By A. Powis Bale. London: Crosby Lockwood and Son, Stationers' Hall-court, E.C. 4. Price 15s. net.

Main Line Railway Electrification.

By Sir PHILIP DAWSON, M. Inst. C.E., &c., Consulting Engineer, and
S. PARKER SMITH, D.Sc., M.I.E.E., Professor of Electrical Engineering, Royal Technical College, Glasgow.

No. I.—SWITZERLAND.

Introductory.—The proposal to electrify the Swiss Federal Railways is not of recent origin, and, indeed, it may be said that in no country has the subject been more carefully or thoroughly investigated from all points of view than in Switzerland.

In 1901 the Swiss Elektrotechnischer Verein appointed a special Commission to study the question of main line electrification under the title of "Schweizerische Studien-Kommission für elektrischen Bahnbetrieb." Dr. Tissot was largely responsible for the formation of this Commission, which comprised representatives of all the Government departments interested and of all the privately owned railways and manufacturers, &c. Amongst its members the following gentlemen may be mentioned:—Colonel E. Huber-Stockar (now Consulting Engineer for the Federal Railways), Dr. Kummer, Dr. Eppser, Dr. Blatiner, Messrs. L. Thormann (Consultant of the Loetschberg Railway), Weber-Sahli, Affeltranger, Strelin, Keller, Baldinger, Woldkirch, H. Egg, W. E. Thomann, F. Eckinger, K. Wirth, and representatives of Brown Boveri, Maschinenfabrik Oerlikon, Alioth, Sulzer Brothers, Rieter and Co., Lokomotivenfabrik Winterthur, &c., the Secretary of the Commission, Professor Wyssling, of Zurich.

The titles of the principal reports issued by this Commission are as follows:—

1906. Energy requirements for operating electrically the Federal Railways.
1908. Fundamental conditions for electric operation of the Federal Railways.
1908. Report on the electric railways of North America.
1908. Choice of periodicity for alternating current traction.
1912. Question of systems and cost for hydro-electric operation of the Federal Railways.
1913. Fundamental technical conditions for electric operation as applied to the Federal Railways.
1914. Report on the electrically operated railways in Europe.
1915. General comparison of the various traction systems.

Encouraged by the results of the preliminary investigations carried out by the Commission, the Maschinenfabrik Oerlikon, in 1905, with the consent of the Swiss Government, electrified the line from Seebach to Wettingen for experimental purposes. It was in 1910 that, as a result of the favourable experience gained on this experimental line, the Bernese Alpine Railway Company decided to electrify the Loetschberg line, then under construction, on the single-phase system; this line was completed and put into regular service in 1913.

The satisfactory reports made by the Commission as regards the benefits to be derived from electrification generally, as well as the difficulty on the St. Gothard Railway of dealing with the ever-increasing traffic, eventually induced the Federal Government to decide to electrify the St. Gothard. As a preliminary step the development of the water powers at Ritom and Amsteg was taken in hand in 1913. These were to furnish the power for operating this part of the Federal Railways. The section between Erstfeld and Bellinzona, a distance of 109 kiloms., was the first to be electrified.

Although the Commission had in its report of 1912 definitely recommended the adoption of the single-phase system, the Federal Railway authorities did not think it advisable to decide the question of systems definitely until the results obtained on the Loetschberg and the Rhaetian railways became available.

(1) HISTORICAL: REASONS FOR ELECTRIFICATION.

The urgent need to electrify the whole of the Swiss railways became apparent during the European War owing to the dependence of Switzerland on imported coal. Under steam operation the whole of the 700,000 tons of coal necessary had to be imported, and during hostilities coal deliveries were very bad as well as very costly.

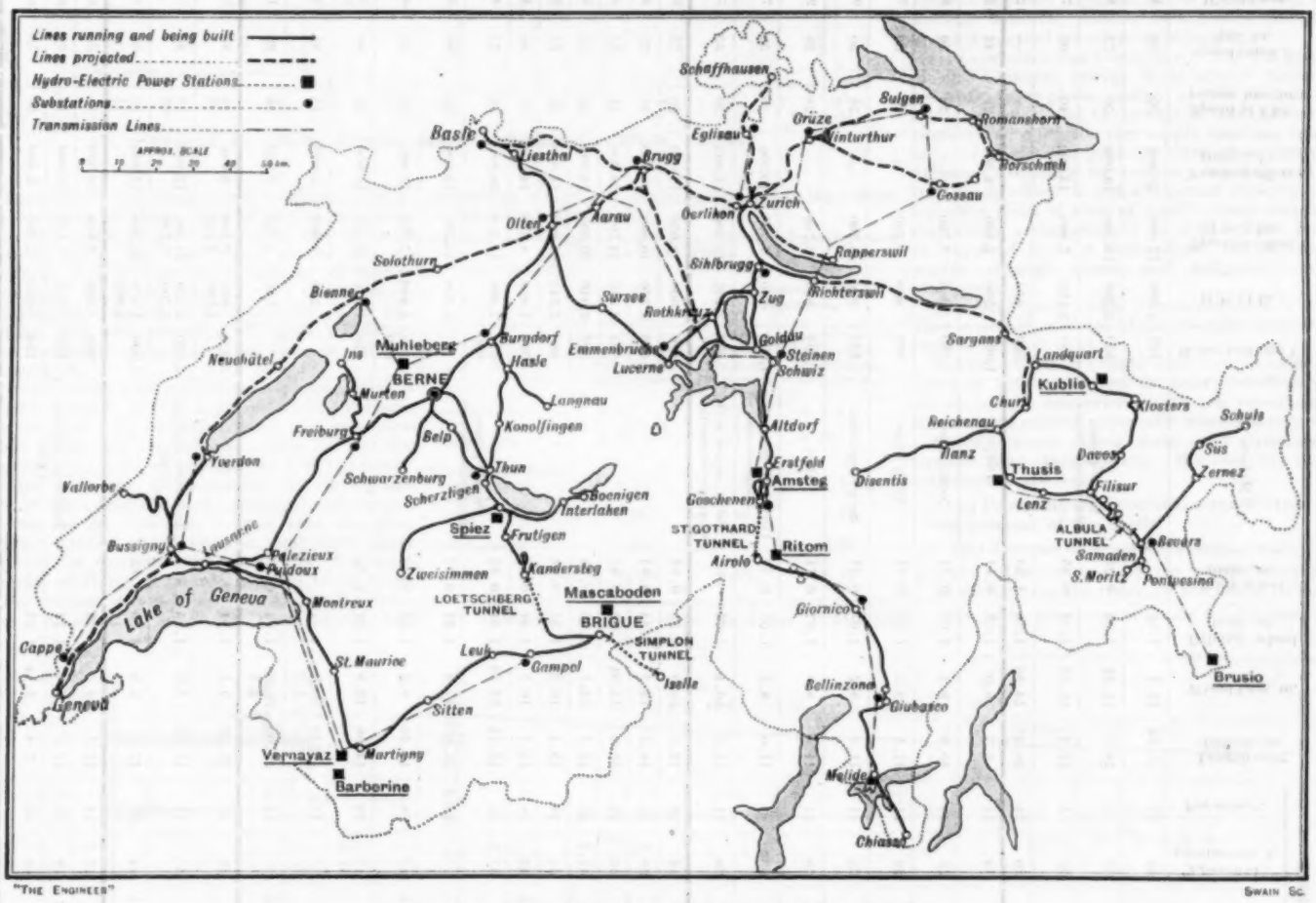
The Swiss Federal lines are about 3000 kiloms. in length, and the mean power would not exceed 75,000 horse-power, or the maximum 200,000 horse-power at the turbines, so that the 3 million horse-power available in Switzerland from water-power sources is more than sufficient for the railways. In 1916 the adoption of the single-phase system at a frequency between the limits of 13⅓ to 16⅔ cycles and at 15,000 volts was definitely proposed. It was only, however, in 1918 that the general programme for the Swiss railways electrification was presented to the Federal Government for approval and definitely agreed to. The Federal lines were divided into three groups, of which the first included all the most important sections; the length of this group is 1128 kiloms.

At the beginning of 1921, a total of 1803 kiloms., excluding urban tramways, had been equipped in Switzerland for electric haulage with direct, three-phase and single-phase current. Of this 1803 kiloms., local lines comprised 1128 kiloms. The remaining 675 kiloms. consisted of 33 kiloms. on the direct-current system (Freiburg-Murten-Ins), 132 kiloms. of three-phase (Burgdorf-Thun, and Iselle-Sion), and 510 kiloms. of single-phase operation. The programme proposed was reconsidered in 1923; it is now intended to accelerate the work, and complete 1529 kiloms. of single-phase lines by 1928.

The whole of the power station, sub-station and line equipment is being carried out to the designs, and under the supervision of, Colonel E. Huber-Stockar, the Consulting Engineer for the electrification of the Federal Railways, whilst the electric locomotives are supplied to the requirements of, and operated by, Mr. Max Weiss, the Chief Mechanical Engineer of the Federal Railways, to whom we are indebted for much of the information contained in this article. Thanks are also due to Director Benner, the head of the Rhaetian Railways; to Mr. Thormann, the Consulting Engineer of the Bernese Alpine Railway, as well as to the Swiss manufacturers who supplied the plant and equipment. The valuable and willing help given by all, as well as the intimate personal acquaintance with the works both during construction and in operation, have been of material assistance in the preparation of this article, in which all possible care has been taken to ensure accuracy.

(2) CHOICE OF SYSTEM.

The various available systems of electrification were very carefully examined, both by the Investigatory Commission and by the officers of the Federal Railways, and the following is a brief account of the data investigated and the conclusions reached by them.



"THE ENGINEER" SWAIN Sc.

FIG. 1—MAP OF SWITZERLAND SHOWING ELECTRIFIED RAILWAYS

(a) *Influence of the Magnitude of the Contact Line Pressure.*—The lower the voltage at the contact line, the fewer are the troubles due to faulty insulation. The lower pressures previously used—600–800 volts—were not usually fatal to human life if accidental contact occurred. For heavy railway traction, however, very large currents are required at this pressure, and for economy the voltage must be raised. The question, therefore, reduces to one of insulation.

Insulation for 15,000 volts is no more difficult than for 1500 volts. Moreover, higher trolley-line pressures mean fewer and smaller feeding points, and, therefore, less cost. With regard to short circuits these depend largely on the amount of energy which can be fed into the fault, and not upon the voltage only. The use of alternating current is here advantageous, since the natural impedance is greater than with direct current; short circuits may, therefore, be expected to be less severe.

The motors have an influence on the choice of line pressure. Alternating or direct-current commutator motors or three-phase induction motors can be used. The neutralised series alternating-current motor works with 500–650 volts as a maximum, so that for high contact line pressures a transformer must be used. The direct-current motor can be built up to 1500 volts, although for safety a lower voltage is better. The contact-line pressure is, therefore, strictly limited and cannot exceed about 3000 volts, assuming two motors of 1500 volts,

TABLE XI.—ELECTRIC ROLLING STOCK ON SWISS RAILWAYS.

Railway.	Rolling Stock.	Number.	Locomotive No.	Axles. Driving.	Axles. Pony.	Type.	Weights. Total, t.	Weights. Adhesive, t.	Weights. Electrical equipment, t.	Weights. Per axle, t.	Length over buffers, m.	Wheel base, m.	Driving wheel diam., m.	Pony wheel diam., m.	Motors.	Motor voltage, V.	H.P. (1 hr.)	Tractive effort (1 hr.), kg.	Tractive effort (max.), kg.	Speed at 1 hr. rating, km./hr.	Speed (max.), km./hr.	Weight per H.P., kg.	No. of motors.	Drive.	Gear ratio.	Speed regulation.	Current collectors.	No. of transformers.	Cooling of transformers.	Braking.
A.	Locomotive ..	1	121	6	0	C–C	90	90	44	17	15.02	10.7	1.35	—	Single-phase, neutralised series	420	2,000	13,000	20,000	30	60	45	2	Gear and connecting-rods	3.25	Variation of transformer voltage	Pneumatically-controlled pantographs	2	Air	Hand and Westinghouse air brakes
BERNESE ALPINE RAILWAY (Berne–Lötschberg Simplon)	Locomotives ..	13	151–163	5	2	1 E 1	107	87	59	17	16.0	11.34	1.35	0.85		320	2,500	13,500	18,000	50	75	43	2	Gear and connecting-rods	2.23			2	Air	
	Locomotives ..	14	301–314	4	2	1 B–B 1	70	50	35	12	14.4	10.55	1.23	0.85		400	1,160	7,800	13,000	40	60	70	2	Gear and connecting-rods	3.78			1	Oil	
	Motor coaches	3	—	2	2	B–2	54	30	20	15	20.3	14.80	1.10	1.10		300	450	—	—	—	—	120	2	Gear	3.45			1	Oil	
B.	Locomotives ..	7	201–207	2	2	1 B 1	37	22	18	11	8.7	6.0	1.07	0.71	Déri	1,000	300	2,880	4,200	28	45	122	1	Connecting-rods	—	Brush shift	Pneumatically-controlled pantographs	1	Oil	Hand and Hardy air brakes
	Locomotives ..	2	351–352	4	2	1 D 1	50	39	22	10	10.8	8.2	1.07	0.71	Neut. series	280	600	5,760	—	28	50	82.5	2	Gear and connecting-rods.	4.45			1	Air	
RHAETIAN RAILWAY	Locomotives ..	3	353–355	4	2	1 D 1	56	44	26	11	11.1	8.2	1.07	0.71	Neut. series	300	800	7,200	—	30	50	70.3	2	Gear and connecting-rods	4.15	Transformer		1	Air	
	Locomotive ..	1	391	4	2	1 D 1	55	41	25	11	11.0	8.2	1.07	0.71	Series-repulsion	400	600	5,760	—	28	50	92.5	2	Gear and connecting-rods	2.65			1	Oil	
	Locomotive ..	1	301	4	2	1 D 1	55	42	29	11	11.5	8.0	1.07	0.71	Déri	1,000	600	5,760	—	28	50	92	2	Triple connecting-rods	—	Brush shift		1	Oil	
	Locomotive ..	1	302	4	2	1 D 1	58	45	29	11	11.0	8.2	1.07	0.71	Déri with resistance connections	1,000	800	7,200	10,000	28	50	72.3	2	Triple connecting-rods	—			1	Oil	
	Locomotives ..	10	401–410	6	0	C – C	66	66	28	11	13.3	10.4	1.07	—	Neut. series with resistance connections	500	1,200	10,500	13,000	30	45	55	2	Gear and connecting-rods	4.3	Transformer		1	Air	Also rheostatic
C.	Locomotive ..	1	11,201	3	2	1 C 1	91	59	44	20	13.5	10.0	1.35	0.93	Single-phase, neutralised series	400	1,600	8,650	17,000	50	75	57	2	Gears and connecting-rods	2.84	Voltage variation by secondary transformer tappings	Pantograph collectors	2	Air	Air
	Locomotive ..	1	12,301	4	2	1 B–B 1	113.5	80	58.3	20	16.2	13.2	1.35	0.93		480	2,320	10,600	20,000	59	75	49.4	4		3.47			1	Oil	
	Locomotive ..	1	14,201	6	2	1 C–C 1	127	103	56	19	19.2	15.84	1.35	0.85		505	2,240	14,700	26,000	41	65	56.6	4		3.24			1	Oil	
	Locomotives ..	40	12,303–42	4	2	1 B–B 1	117	77	47.2	20	16.5	13.5	1.35	0.93		505	2,040	10,600	18,000	52	75	54.5	4		3.2			1	Oil	
	Locomotives ..	33	14,251–83	6	2	1 C–C 1	128	109	55	18	19.4	16.5	1.35	0.93		400	2,240	16,800	24,000	36	65	57	4		4.03			1	Oil	Rheostatic
	Locomotives ..	26	10,301–26	3	3	2 AAA 1	82.3	55.3	42	18.5	14.7	10.7	1.61	0.93		505	1,890	8,350	14,000	61	90	49	3		2.57			1	Oil	Air
SWISS FEDERAL RAILWAYS	Locomotives ..	6	12,501–06	4	3	1 AA 1–AA 1	110.5	74	55.5	19	16.24	13.64	1.61	0.93		twin 660	2,400	11,500	20,000	56	75	46	4 twin	Individual axle drive	5.71			1	Oil	
	Locomotive ..	1	11,000	4	4	1AA1+1AA1	126.8	73	—	18.5	21.0	17.0	1.61	0.93			2,520	11,100	18,600	61	90	50.5	4		2.58 2.57			2	Oil	Rheostatic
	Locomotives ..	20	10,201–20	3	2	1 AAA 1	81.1	55.5	42	18.5	12.26	9.3	1.61	0.93		twin 660	1,800	7,700	14,000	63	90	45	3 twin		5			1	Oil	Air
	Locomotives ..	20	10,401–20	3	3	2 C 1	100 98	57	43.5 41.6	19	14.09	10.8	1.61	0.93		410	1,840	8,300	14,000	60	90	54.3 53.2	2	Gear and connecting-rods	2.224			1	Oil	Regenerative
	Motor coaches	2	9,701–02	4	0	AA–AA	60	60	—	15	17.50	Bogie 2.5	1.04	—			500	3,000	5,600	45	85	120	4	Nose suspension	3.15					Air
	Motor coaches	14	9,801–	4	2	A1A–A1A	85.3	58.2	—	14.5	20.00	Bogie 3.2	1.04	0.85			780	4,360	9,000	54	90	109	4		3.65					
D.	Locomotives ..	2	364–65	3	2	1 C 1	62	44	29	15	12.32	9.7	1.64	0.85	Induction motors, 3-ph.	3,000	800 1,100	6,400 4,400	9,000	34 68	80	57	2	Connecting-rods	—	Pole-change	Double bow	—	—	
SWISS FEDERAL RAILWAYS	Locomotives ..	4	366–69	4	—	D	68	68	35	17	11.64	8.9	1.25	—		3,000	1,100 1,700	11,500 9,700	12,000	26 69	80	46	2		— —			—	—	
	Locomotive ..	1	371	4	2	1 D 1	88.4	69.4	44	17	12.5	8.8	1.25	0.85		3,000	1,050 2,800	10,800	15,000	26 71	65	32	2		—			—	—	
E.	Locomotive ..	1	4	4	—	B–B	44	44	15.2	11	13.8	10.6	1.23	—	Induction motors, 3-ph.	750	500	9,650	10,000	14	65	87.6	2	Gear and connecting-rods	6	Pole-change	Double bow	—	—	
BERGDORF THUN RAILWAY	Locomotive ..	1	3	4	—	B–B	42	42	18	10.5	12.6	9.4	1.23	—		750	500	8,700	10,000	15.5	65	84	2		4			—	—	
	Locomotives ..	2	1–2	2	—	B	30	30	10	15	7.8	3.14	1.23	—		750	300	2,200	4,400	36	36	100	2		1.88 3.72	Gear-change		—	—	
F.																														

or three motors of 1000 volts each, &c., are connected in series; but in any case the motor insulation must be designed for the full line pressure. The three-phase induction motor can be provided with a transformer, but other considerations tend to limit the line pressure to about 3000* volts. The single-phase motor possesses the advantage of economical speed regulation with the variable ratio transformer used for reducing the line voltage; the influence of a transformer with a 15,000-volt primary winding on the safety of working must, however, be considered, as it must stand over-pressures, surges, atmospherics, earths, &c., met with in railway service.

From the point of view of weight per horse-power the three-phase construction, where low line pressures are used—3000 volts—is best, since no transformer is necessary. For 15,000-volt single-phase and 3000-volt direct-current construction, the weights are rather higher than for three-phase, the single-phase being sometimes lighter than the direct-current construction. Maintenance costs are least with three-phase working; the other two are about equal.

(*c*) *Efficiency of System.*—The efficiency of the system depends on the efficiency of energy distribution between generating plant and the point where the energy is used, *i.e.*, the dynamo shaft to the wheels of the train. See Table I.

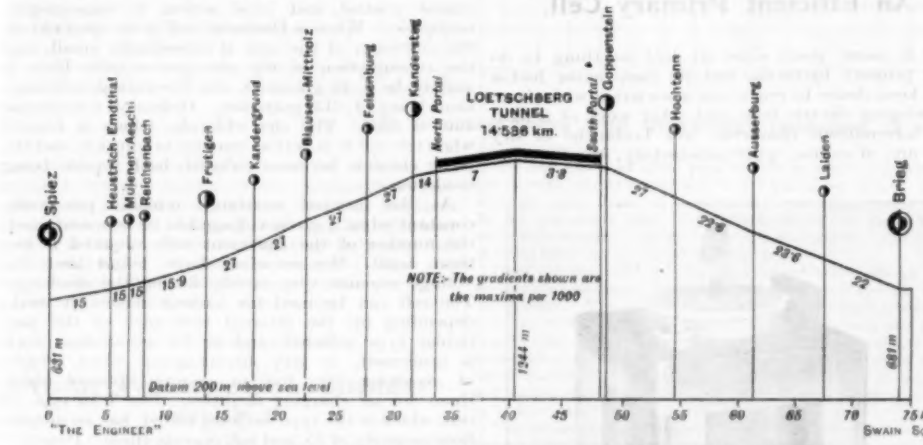


FIG. 2 PROFILE OF TUNNEL SECTION—BERNE-LOETSCHBERG-SIMPLON RAILWAY

(*b*) *Locomotives and Motor-coaches.*—From a technical standpoint all three types of motors are satisfactory, the single-phase allowing of better speed regulation, while the three-phase motor has no commutator and is best for simplicity of energy regeneration. From the point of view of efficiency, the single-phase motor is theoretically at a disadvantage, but the economy of speed regulation without resistance compensates, to some extent, for this drawback.

For motor-coach working the single-phase system is at present superior, in that high contact-line voltages can be retained. On the other hand, the restriction of space limits the single-phase motor to 200–300 horse-power per axle as opposed to 300–350 horse-power per axle for direct-current or three-phase motors. Single-phase and high-pressure direct-current motor coaches are relatively heavier than low-pressure direct-current motor coaches, and more space is required for control apparatus. For the most economical working of motor coaches in multiple unit, low-voltage direct-current is the most advantageous. A solution involving more space and heavier weights, but otherwise quite satisfactory, exists with single-phase, and in Europe motor-coaches are running successfully on the Loetschberg line, the Swiss Federal Railways, the Blankenese-Ohlsdorf line, and the Brighton Section of the Southern Railway; while in the United States coaches are running on the New York New Haven and Hartford, the New York Westchester and Boston, and the Pennsylvania lines.

TABLE I.—*Mean Efficiency of Energy Utilisation from Generator to Locomotive Wheels.*

	D.C., 3000 v.		Single-phase, 15,000 v., 16⅔ periods.		
	Converted from high-voltage three-phase, 50 periods.		Generated single-phase at 16⅔ periods		Converted from high-voltage three-phase, 50 periods.
Locomotive	0.8	0.72	0.76	0.7	0.76	0.7
Contact line	0.9		0.92		0.92	
Converting machinery (rotary)	0.78		—		0.8	
Double transformation	0.90		0.91		0.91	
Transmission	0.94		0.94		0.94	
Total	0.475		0.60		0.48	

If mercury rectifiers were used for obtaining direct-current, the conversion efficiency would be of the order 0.98, so that the direct-current system would have the same overall efficiency as the all single-phase system.

(*d*) *Energy Distribution.*—The cost of energy distribution clearly depends on the number of feeding points; further, the higher the line pressure, the fewer the number of feeding points required for a specified percentage line drop. The following table shows the distance between feeding points, &c., for the two cases of direct-current and single-phase working—where 3000 kilowatts are required at the end of a line, and 30 per cent. pressure drop is allowable. The cross section of copper for the two direct-current cases is 200 and 800 square millimetres, and for the single-phase 200 square millimetres. The return is by rails of 40 kilograms-per-metre weight.

TABLE II.—*Comparative Distances Between Feeding Points.*

	Direct-current.		Single-phase.
Copper cross-section, mm²	200	800	200
Resistance per kilometre of line—			
Overhead wire, ohm	0.08	0.02	
Track, ohm	0.02	0.02	
Total, ohm	0.10	0.04	About 0.24
Energy required at end of line, k.w.	3,000	3,000	3,000
Pressure at feeding end, volts	3,000	3,000	15,000
Pressure at load end (30 per cent. drop), volts	2,100	2,100	10,500
Current required, amps.	1,430	1,430	320*
Distance, km.	6.3	15.7	58.5

* Power factor = 0.9.

Thus, the number of feeding points required with direct-current may, from this standpoint, be 3 or 4 times the number with single-phase.

The energy loss in single-phase transmission is greater than with three-phase, but with the latter two contact-lines are required, which necessitates a lower voltage between phases, and makes complication at junctions and crossings considerable.

(*e*) *Generation and Conversion.*—For the generation of direct-current energy it is almost universal to generate three-phase energy at the normal industrial frequency, and to convert in sub-stations. With single-phase a station can supply traction frequency only, or it can also generate three-phase energy at a different frequency for ordinary lighting and industrial load, which is not altogether disadvantageous from the point of view of short circuits and pressure regulation. Alternatively a single-phase load can be supplied from a three-phase normal-frequency supply through phase- and frequency-converting machinery.

(*f*) *Interference with Communication Circuits.*—This is usually a factor of considerable importance—see also Section 5 (*e*).

DIRECT-CURRENT: Static induction is of no importance at 3000 volts, but dynamic induction may be set up by the converters or by the commutators of the traction motors, especially when starting up.

SINGLE-PHASE: Both static and dynamic interference may take place. Methods of obviating interference are:—

(i.) Providing all-metallic communication circuits independent of the earth.

(ii.) The use of a counter-pressure wire.

(iii.) The removal of the communication lines 50–60 m. from the track, or the use of cables.

(iv.) The provision of a safe track-return for the

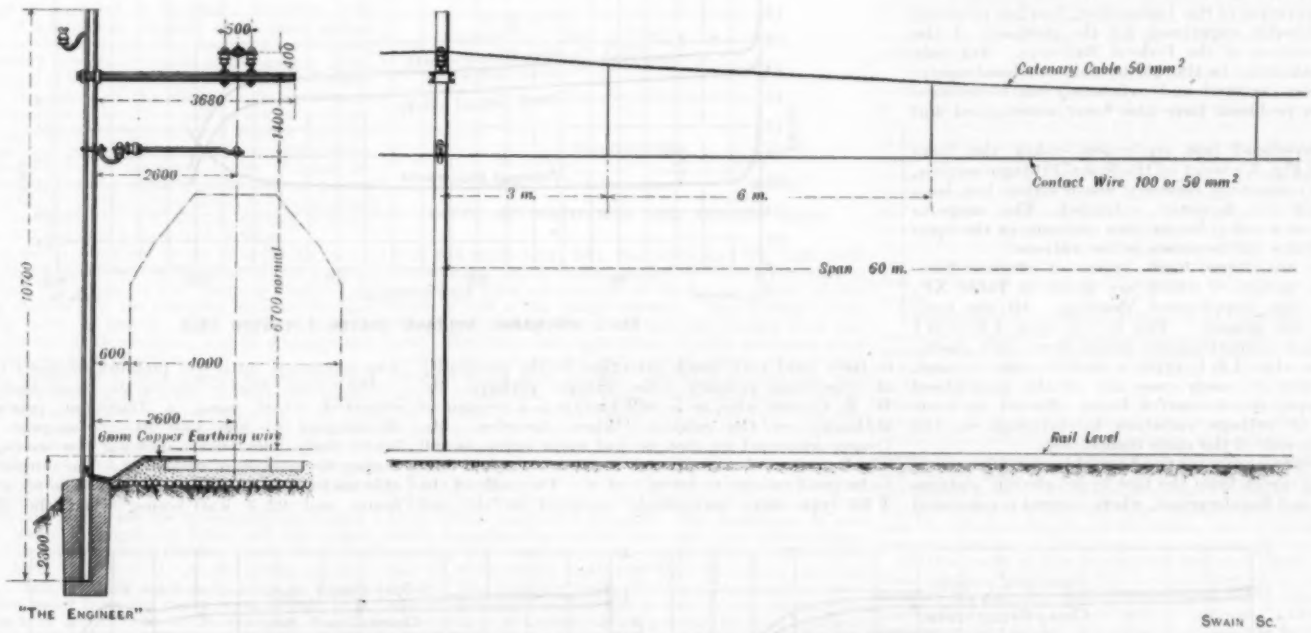


FIG. 3—OVERHEAD CONTACT LINE CONSTRUCTION—BERNE-LOETSCHBERG-SIMPLON RAILWAY

* This pressure has since been exceeded.

train current by subdividing the track into sections connected with milking-transformers.

Stress has been laid on the cost of the alterations necessary to the communication lines. This disadvantage has not great importance in Switzerland. Usually the weak current circuits must be removed in any case, because they are in the way of the electrification work. The maintenance of circuits near the power lines is a source of danger to the staff responsible for upkeep. These remarks apply

to railway electrification in general, and in Switzerland the question did not have much influence on the choice of the system.

Careful study of the above considerations with reference to Swiss conditions led the Swiss Federal Railways Directorate to standardise single-phase traction at 15,000 volts and $16\frac{2}{3}$ cycles. The directorate was also influenced by the good results obtained on the Loetschberg and Rhaetian Railways, and by the advisability of selecting a system with which the Swiss manufacturers were already familiar.

(3) PRESENT STATE OF ELECTRIFICATION.

Fig. 1 is a map of the Swiss electrified railways as at present operating or projected. Only the main lines and the most important of the other electrifications are shown, as this article does not deal with light railways or tramways, the operating conditions of which differ totally from main line working.

A summary is given in Table X. (see Supplement) of general, contact line, and power supply data for the main line railways treated below. This table covers, as far as is possible, the whole system from powerhouse to the track. It is arranged in a convenient form for reference, and it summarises and augments the text.

(4) A. THE BERNE–LOETSCHBERG–SIMPLON RAILWAY.

The Loetschberg line, opened in 1913, was built by the Bernese Alpine Railway Company, to provide a through connection between Berne, the capital of Switzerland, and Italy, by linking up with the Simplon Tunnel Railway at Brigue. The line has been worked electrically from the outset. The Spiez–Frutigen section was electrified experimentally in 1910, but experience with a 15,000-volt overhead contact line in tunnels had yet to be gained. Gradients are steep in places, the maximum being 27 in 1000. Curves also are sharp; an S-loop occurs between Frutigen and Kandersteg, where the line climbs up into the Bernese Oberland. The entrance to the Loetschberg Tunnel—14.5 kiloms. long—is just above Kandersteg. The exit is at Goppenstein on the southern side. A profile of the tunnel section is given in Fig. 2. In addition to avalanches, trouble has been experienced from landslides, entailing numerous galleries. The line terminates at Brigue Station, the northern end of the Simplon Tunnel, electrified on the three-phase system. Here some of the tracks are equipped with single-phase contact-lines, others with three-phase equipment. Through trains are shunted from one track to the other by steam locomotives.

In 1915 the electrified line was extended northward from Spiez to Scherzligen, and in 1920 the branch line Spiez–Interlaken–Boenigen was similarly electrified. In addition, the company has completed the electrification of the following three sections of the Bernese Subsidised Railways:—Spiez–Zweisimmen; Berne–Belp–Thun; Berne–Schwarzenburg; totalling 90 kiloms. The last line mentioned has gradients up to 35 per cent. With the exception of the Loetschberg Tunnel and Spiez–Frutigen, all the lines have single tracks. Since the Federal section Berne–Scherzligen is now electrified, all traffic between Berne and Brigueis electrically hauled.

The operation of the Loetschberg line has provided much valuable experience for the guidance of the Administration of the Federal Railways. Not only have weaknesses in the 15,000-volt overhead equipment been detected and overcome, but locomotive vibration problems have also been investigated and solved.

The overhead line equipment takes the form shown in Fig. 3, except on the Spiez–Frutigen section, where a compound catenary construction has been tried, but not, however, extended. The supports are iron or wood poles let into concrete in the open track, or iron lattice masts in the stations.

There are three main types of electric locomotives, details of which are given in Table XI., and in our Supplement drawing. All the locomotives are geared. The C—C and 1B—B1 types have connecting-rod drives from jack shafts, while in the 1E1 type a Scotch yoke is used. The motors in each case are of the neutralised series type, speed control being effected by some method of voltage variation by tappings on the secondary side of the main transformer.

The power supply for the Loetschberg Railway was originally direct from the two hydro-electric stations at Spiez and Kandergrund, where current is generated at 15,000 volts $16\frac{2}{3}$ periods, *i.e.*, at the traction voltage and frequency. These stations in the Kander Valley are practically by the side of the line, and an appreciable saving in capital, maintenance and running costs has been effected by the avoidance of substations and transmission lines. Spiez has a storage capacity of 280,000 cubic metres, at a head of 64 m., while the Kandergrund Station has a 298 m. head, but no storage. In 1921 the new hydro-electric station at Mühleberg, on the river Aare, was added to the system. This station has a 29 m. head, and a storage capacity of 10 million cubic metres. Three-phase energy is generated, and the traction load is obtained through motor-generator sets.

An Efficient Primary Cell.

IT is many years since we had anything to do with primary batteries, and we have never had a very keen desire to renew our association with them. For ringing electric bells and other work of a light and intermittent character, wet Leclanché or dry cells are, of course, quite satisfactory, but for more arduous duties primary batteries have not in the past proved particularly advantageous. The cost and trouble of renewing the zincs and chemicals used for charging them have caused most electrical workers to reject primary cells and to use accumulators, which, of course, have to be charged from a dynamo or a public supply system.

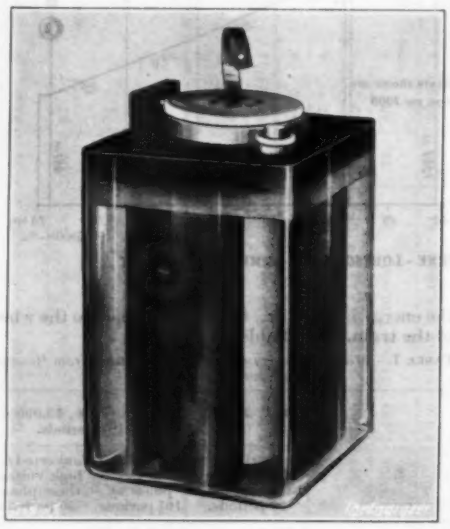


FIG. 1—THE DARIMONT CELL

For a long time past no one in this country seems to have paid very much attention to the possibility of improving primary cells, except, perhaps, Mr. W. R. Cooper, who, as is well known, is a recognised authority on the subject. When, therefore, Mr. Cooper informed us that he had come across a cell which possessed exceptional merits, we asked him to be good enough to let us test it. Two cells of the T 15 type were accordingly supplied to us, and from the results obtained we can safely say that the cells are a marked advance on anything in the way of primary batteries that has hitherto come before our notice.

The new cell is the invention of a Belgian engineer, Mr. Leopold Darimont, and it is supplied by Darimont Electric Batteries, Limited, of 536, Salisbury House, E.C. 2. It is of the two-fluid type, which generally has marked advantages over single-fluid cells in that the current is more constant because the depolarisation is more effective. The Darimont cell—shown in Fig. 1—naturally has a porous pot, and the plates are composed of carbon and zinc. The liquid depolariser round the carbon consists largely of ferric chloride; whilst the electrolyte round the zinc consists of an emulsion made up of sodium chloride, calcium carbonate, and other materials, so that the electrolyte is always maintained neutral, and local action is consequently negligible. When a Darimont cell is on open circuit the corrosion of the zinc is exceedingly small, and the consumption of the zinc per ampère hour is said to be 1.25 grammes, the theoretical consumption being 1.213 grammes. Ordinary commercial zinc is used. The zinc chloride, which is formed when the cell is in action, remains in solution, and the ferric chloride becomes reduced, both liquids being inodorous.

As the internal resistance remains practically constant when a given voltage has to be maintained, the number of the Darimont cells required is less than usual. We ourselves have found that the voltage remains very steady during the discharge. The cell can be used for various classes of work, depending on the internal resistance of the particular type selected, and as far as wireless work is concerned, is very advantageous when owners of receiving sets live in country places where there are no charging facilities. The T 15 type of cell, which is the type we have tested, has an ampère hour capacity of 75, and will operate three "Peanut" valves for 100 hours.

The curves shown in Fig. 2, however, give more detailed information about the performance of those cells, and as they were prepared from tests carried out at the Physical Laboratory they may be taken to be correct. These curves relate to a T 10 type of cell, which has a nominal capacity of 50 ampère-hours. On test the capacity of the cell was found to be 48.9 ampère-hours, when the cell was discharged through a resistance of 10 ohms down to 1 volt the corresponding watt-hours being 62.1. The zinc consumed per ampère-hour was 1.25 grammes, the theoretical figure being, as we have said, 1.213. The curve—Fig. 3—shows the results obtained with the larger T 15 type of cell, with a normal capacity of 75 ampère-hours. In this case the test was also made on a continuous discharge with a resistance of 10 ohms. The output obtained was 75 ampère-hours and 98 watt-hours, the discharge being maintained until the pressure across the cell dropped to 1 volt. The curve—Fig. 4—shows the results obtained when a cell of the same type was run on a continuous discharge with 5 ohms resistence, the ampère hour capacity being 73.8 and the watt hour capacity 96, when the discharge was continued until the pressure dropped to 1 volt.

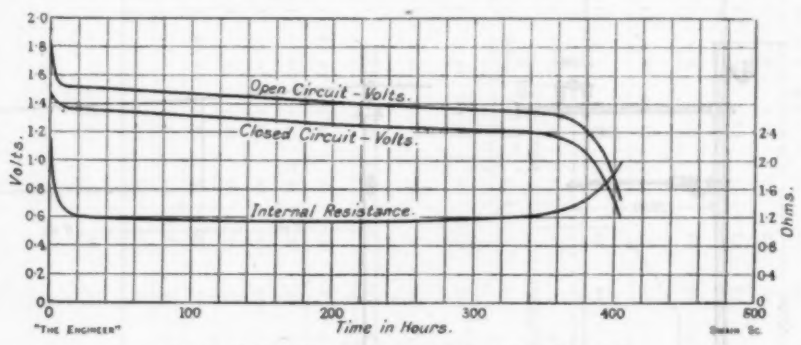
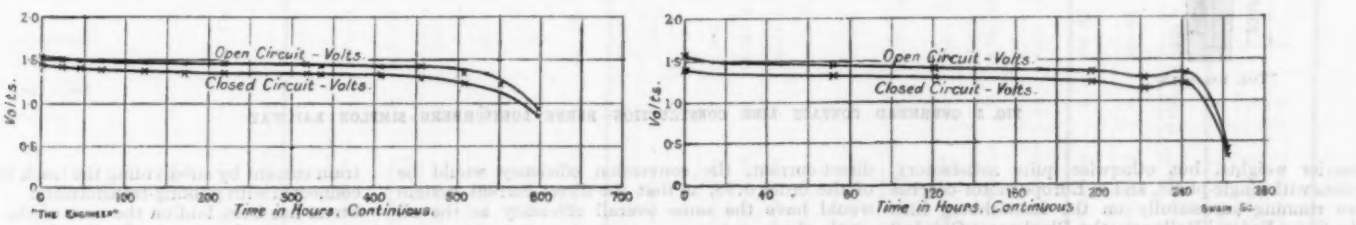


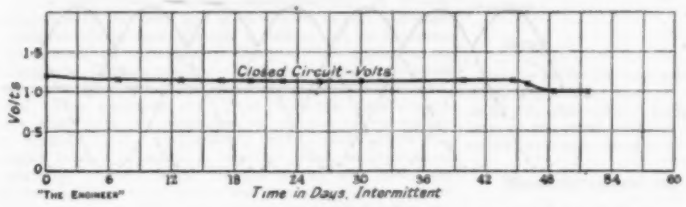
FIG. 2—DISCHARGE VOLTAGE CURVES T 10 TYPE CELL

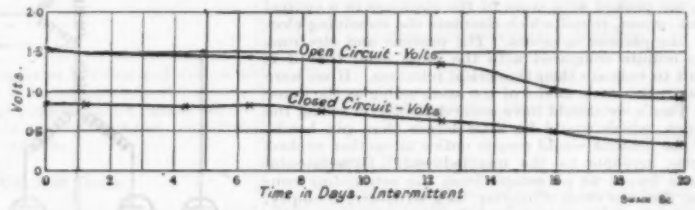
The curve—Fig. 5—shows the result that may be expected when using a Darimont primary cell discharging at the rate of .75 ampère for two hours daily, the curve showing the average volts during the periods of discharge. The output obtainable under these conditions is said to be 85.5 ampère-hours and 92.3 watt-hours, when the discharge is continued down to 1 volt. The curve—Fig. 6—shows the open and closed circuit volts when the T 15 type of cell is used for intermittent discharges of 1.5 ampères for two hours daily. These curves



FIGS. 3 AND 4—T 15 TYPE CELL—DISCHARGE VOLTAGE CURVES WITH 10 AND 5 OHMS RESISTANCE

clearly indicate that the performance of this Darimont primary battery is somewhat remarkable. Some very thorough tests have also been made by Dr. Max Riepe, head of the Technical High School, Berlin. Dr. Riepe found that the cells he tested gave even greater watt hour and ampère hour outputs than those specified by the makers, and a translation of his report supplied to us sums up by saying that, in his opinion, the Darimont battery represents an extraordinary advance in the field of primary cells, and that in places where there are no charging facilities the cells may be used advantageously for lighting purposes and for the operation of wireless receivers. The cell may, of course, also be used for many other purposes, such as working telegraphs, signals, &c.





FIGS. 5 AND 6—VOLTAGE CURVE WITH INTERMITTENT DISCHARGES OF 0·75 AND 1·5 AMPERES

Bristol Waterworks: Cheddar Supply.*

By ALEXANDER McCULLOCH PATERSON, M. Inst. C.E.

THE present Bristol Waterworks Company was incorporated in 1846. Before that date the city was supplied by numerous springs and wells. Since then, but previous to the Cheddar scheme, works have been undertaken from time to time, which give a daily average supply of 12½ million gallons to a population of 400,000. In 1914 it was decided to obtain water from Cheddar, at the foot of the Mendip Hills, 19 miles south-west of Bristol. This scheme provides for the abstraction of water from the stream at Cheddar, which is formed by numerous springs breaking out of the limestone at the foot of the gorge, its gravitation to a pumping station 1 mile below the intake, and pumping from there into Yeo Reservoir, 9¼ miles distant. The Cheddar supply is at present a standby, to be made use of from time to time as required. The present capacity of the pumping station is 6 million gallons per diem, with three equal units in operation. When consumption increases so as to justify an extension, it is proposed to duplicate the pumping plant, with a maximum operating capacity of 10 million gallons per diem, one unit standing idle.

Gaugings of the flow of the stream have been taken daily since the end of 1915. These record a fluctuation in flow from 2.2 million gallons per diem on November 1st, 1921, to 83 million gallons on January 7th, 1919. The average daily flow, from 1916 to 1922 inclusive, but omitting 1921, is 17.9 million gallons with an average annual minimum of 4.9 million and maximum of 69.9 million gallons.

No storage is provided at Cheddar; therefore, with pumps each of a minimum capacity of 2 million gallons per diem, the minimum stream-flow upon which a pumping unit can feasibly operate is 5 million gallons per diem, 3 million gallons being required for compensation water. Working on this figure as the minimum, in an average year a daily average of 5 million gallons can be pumped. It is ultimately intended to provide a storage reservoir of 2 million gallons capacity close to the pumping station. When the installation is increased to its ultimate intended maximum working capacity of 10 million gallons per diem the daily average expectation for an average year would be raised to 7.3 million gallons without storage, and to 7.9 millon gallons with storage.

The various works comprised by the undertaking are:—(1) The intake on the stream at Cheddar; (2) a gravitation main from the intake to the pumping station; (3) the pumping station; (4) the pumping main to the Yeo Reservoir, 9¼ miles in length; (5) a service reservoir at the summit point at Rowberrow; and (6) drainage and other protection works at Cheddar.

The intake consists of a pond formed by constructing a dam across the stream, with a covered concrete intake tank having six arched inlets communicating with the pond. The water to be passed downstream is admitted to a gauge chamber by a circular orifice gauge built through the dam, of such a diameter that water cannot pass into the intake tank until 3 million gallons per diem is passing through the gauge.

The gravitation main—see the accompanying engraving—is 1900 yards in length, of 33in. cast iron pipes, and conveys the water through Cheddar, from the intake tank—water level 65.4ft. O.D.—to the pump inlets—51.0ft. O.D. The pumping main is 9¼ miles in length. It conveys the water from the pump level of 53ft. O.D. over a summit of 305ft. O.D. at Rowberrow, 5 miles distant, and thence down to Blagdon, discharging into the Yeo Reservoir at a level of 148ft. O.D. The maximum static head is 296ft. The main is 33in. in diameter—of B or C class cast iron pipe, according to the level—as far as the 7¼ mile point. From there to Blagdon it is 24in. in diameter. The ground traversed by the pipe track is generally red marl overlying the dolomitic conglomerate. For 1¼ mile the trench was cut through this rock. The summit hill at Rowberrow is of carboniferous limestone, through which a tunnel was driven. In the low-lying ground near Axbridge peat was encountered for 400 yards, and in one place the pipes were carried on concrete piers for 200 yards.

The chief interest of the pipe laying was the comprehensive employment of mechanical plant for the work. This comprised a steam excavator, pneumatic hammers for setting up the joints, a petrol-driven backfiller, and a petrol locomotive on a 2ft. railway for distributing the pipes. Records of the cost of pipe laying are given in the Appendix to the paper.

The steam excavator was used throughout, excepting in lengths where rock was met. Under best conditions it cut 440 yards of 33in. pipe trench in a 40-hour week. Its normal rate of travel was 6 or 7 yards per hour. The average total cost of excavation was approximately 3s. 3d. per cubic yard, with labour at 1s. 7d. per hour, and plant bought when prices were a maximum. The cost of hand excavation would have been 5s.

Over 75 per cent. of the pipe joints were set up by pneumatic caulkers operated by a petrol-driven air compressor. The joints of the whole of the high-pressure sections of the pipe line were caulked in this way, and the results are considered satisfactory. The joints are of lead—2¾in. deep in the 33in. pipes—poured against the usual backing of yarn. The jointers worked in pairs, and under good conditions two men would set up a joint in 15 minutes.

The backfiller is a petrol-driven machine which drags the material into the trench by means of a scoop working on a drag line. The cost of refilling the 33in. pipe trench by its means was 4s. to 4s. 6d. per lineal yard, which represents little, if any, saving over hand labour.

Rowberrow Tunnel is situated at the summit of the pipe line, a little over 5 miles from the pumping station.

ROUTE OF GRAVITATION AND PUMPING MAINS

It is 224 yards long, 10ft. 6in. wide, and 8ft. high, with a maximum depth below ground of 75ft. The pipe is carried on piers on one side of the tunnel, whilst on the other is laid a 2ft. gauge railway. The driving of the tunnel took nearly 9 months, and was worked from one face. Both day and night shifts of eight men each were worked for the second half of the period, the weekly progress being 25ft. to 30ft. Machine drilling was employed throughout. The charges were fired by electricity. The average cost of excavation per cubic yard was 50s. A length of 65 yards was lined with 1:3:6 concrete 18in. thick, which saved 25 per cent. of the cost of brickwork.

The pumping station is situated close to Cheddar Station and alongside the Great Western Railway, a siding from which enters the grounds. The buildings, of red brick, comprise the engine-house and four outbuildings, namely, the board room, workshop block, boiler-house and oil store, and a small combined coal store and tool house. The pumping plant consists of three independent sets of high-speed centrifugal pumps driven through the intermediary of toothed helical gearing, by solid injection crude-oil engines. Under the contract each unit is capable of pumping 2 million gallons per diem—1400 gallons per minute—against a total head of 306ft. The engines are of the Ruston-Hornsby two-cylinder horizontal type, built for a working load of 234 brake horsepower. The pumps are Mather-Platt 8in. split-casing five-stage centrifugals, designed to run at a speed of 1000 revolutions per minute.

The official pumping trials took place in January, 1923, and were conducted by Captain H. Riall Sankey, C.B. The conditions under which the plant will operate initially are materially different from those which will ultimately obtain. The specified head of 306ft. allows for pumping from the future storage reservoir at the pumping station, as against the present working under the head from the intake, and is calculated on the pipe friction caused by five units in simultaneous operation, instead of three. For the purpose of the trials, it was necessary to run the plant under conditions approximating as closely as possible to those specified. The present working head with three pumps running is about 261ft., and an artificial head was, therefore, imposed by throttling the delivery valves. With the head increased in this manner to 303ft. a pump discharge of 1680 gallons per minute was obtained. The oil consumption per brake horse-power hour under these conditions was 0.44 lb., or 0.62 lb. per horse-power delivered to the main with a brake horse-power of 220.

Tests were made by the author at a reduced speed, the delivery valves being fully open. With the three units running together the oil consumption was 0.42 lb. per brake horse-power hour, or 0.59 per pump horse-power hour, at an average of 170 brake horse-power per unit and a pump efficiency of 73 per cent.

Rowberrow Reservoir is built close to the summit of the pipe line, and the eastern end of the tunnel. It has a capacity of 500,000 gallons and will act as a service reservoir for supplying water to the Axbridge Rural District Council. It is 90ft. square, with a water depth of 10ft., and is of concrete with brick-faced walls.

Drainage and sewerage works have been provided at Cheddar. Property at and above the intake has been bought to keep control of the stream, and the latter is covered in for 80 yards above the intake pond. To operate the compressed-air ejectors on the drainage system, a small water-turbine plant supplied by an automatic radial sluice was installed on the stream.

* Abstract of a paper to be brought forward for discussion at the Institution of Civil Engineers.

Atoms and Isotopes.*

By Dr. F. W. ASTON.

THAT matter is discontinuous and consists of discrete particles is now an accepted fact, though it is not obvious to the senses on account of the extreme smallness of the particles. Some idea of their size and numbers can be gained by the hypothetical division of a piece of matter into smaller and smaller pieces until the ultimate atom is reached. For this purpose a model decimetre cube of lead is taken and cut in such a manner that after each operation a similar cube of half the linear dimensions and one-eighth the volume results. Modern science shows that this operation can be repeated no less than twenty-eight times before the ultimate atom of lead is reached, and that the number of atoms in the original cube is so enormous that, placed in a string as close together as they are in the lead, they would extend over six million million miles. Again, if an ordinary evacuated electric light bulb were pierced with an aperture such that one million molecules of the air entered per second, the pressure in the bulb would not rise to that of the air outside for a hundred million years.

Dalton, in his atomic theory, postulated that "Atoms of the same element are similar to one another and equal in weight," a simple and definite conception which has been of inestimable value in the development of chemistry. A little later Prout suggested that the atoms of all elements were made of atoms of a primordial substance which he endeavoured to identify with hydrogen. If Dalton and Prout were both right, the chemical atomic weights should all be whole numbers, hydrogen being unity. Chemical evidence was against this, and Prout's theory was abandoned for the time. We cannot test the truth of Dalton's postulate by chemical methods, since these require countless myriads of atoms, and therefore only give a mean result.

The weights of individual atoms can be investigated by means of the analysis of positive rays, and the early experiments of Sir J. J. Thomson suggested that one element—neon—had atoms of two different weights, but the method of analysis was not accurate enough to prove the point. The requisite accuracy has been obtained by means of an instrument called the "mass-spectograph." In this the charged atoms in a beam of positive rays are sorted out according to their weight by means of magnetic and electric fields so that they strike a photographic plate at different points. A mixture of atoms of different weights will give a series of focussed lines called a mass spectrum, and the relative weights of the atoms can be calculated from the position of their lines to an accuracy of 1 in 1000.

As the result of this analysis it has been shown that neon (atomic weight 20.20) is a mixture of atoms of weights 20 and 22. These constituents have identical chemical properties and are called "isotopes." Chlorine (atomic weight 35.46) is a mixture of isotopic atoms of weights 35 and 37. About half the elements so far analysed turn out to be mixtures, and some are very complex. Thus krypton has six, tin at least seven, and xenon possibly nine constituent isotopes. Recently, by means of the method of "accelerated anode rays," the work has been extended to many metals, and already some fifty of the eighty-four known non-radioactive elements have been analysed into their constituent isotopes or shown to be "simple."

Most important of all is the fact arising out of these measurements that all true weights of atoms can be expressed as whole numbers to a very high degree of accuracy. This remarkable generalisation known as the

* May Lecture to the Institute of Metals.

"whole number rule" has removed the last obstacle in the way of a simple unitary theory of matter. We now know that Nature uses the same bricks in the construction of the atoms of all elements, and that these standard bricks are the primordial atoms of positive and negative electricity, protons and electrons.

According to the nucleus theory of the atom first suggested by Sir Ernest Rutherford, which has led to such wonderful advances recently in the hands of Professor Bohr, all the protons, which are much heavier than electrons, are packed with some of the electrons in a central nucleus or sun, round which circulate the remaining electrons like planets in orbits. The protons and electrons are so minute compared with the atom itself that it is difficult to indicate their numerical relations. If we were to construct a scale model of the atom as big as the dome of St. Paul's we should have some difficulty in seeing the electrons, which would be little larger than pin heads, while the protons would escape notice altogether as dust particles invisible to the unaided eye. Experimental evidence leaves us no escape from the astounding conclusion that the atom of matter, as a structure, is empty, empty as the solar system, and that what we measure as its spherical boundary really only represents the limiting orbits of its outermost electrons.

All the chemical and spectroscopic properties of an atom depend on the movements of its planetary electrons, and these in their turn depend on the positive electric charge on the central nucleus. In the case of isotopic atoms the net positive charge on their nuclei is the same, giving identical chemical properties, but the total number of protons is different, giving different atomic weights.

Transmutation of one element to another can only be achieved by the disruption of the nucleus. This requires enormous forces, but by the bombardment of atoms by swift alpha particles Rutherford has succeeded in breaking up the nuclei of several of the lighter elements. This transmutation only takes place as the result of a direct hit on the nucleus, the chance of which is only one in many millions. The quantity of matter so transmuted is indeed almost inconceivably small, but it is the first step towards the release and control of the so-called "atomic energy." We know now with certainty that four neutral hydrogen atoms weigh appreciably more than one neutral helium atom, though they contain the same units, four protons and four electrons. If we could transmute hydrogen into helium matter would therefore be destroyed and a prodigious quantity of energy would be liberated. The transmutation of the hydrogen contained in one pint of water into helium would set free sufficient energy to propel the Mauretania across the Atlantic and back at full speed. With such vast stores of energy at our disposal there would be literally no limit to the material achievements of the human race.

Thermionic Valve Rectifiers.

SOONER or later the practice of employing rotating machinery for converting alternating current into direct current will, no doubt, be abolished, and possibly it may ultimately be found that a static piece of apparatus can also be used for the reverse operation. The mercury vapour rectifier has already been installed in a number of traction and other sub-stations, but there is another contrivance which may also come into use, namely, the thermionic valve. As most people know, these valves will rectify, amplify and generate oscillations. They are, of course, used on an extensive scale in connection with radio communication. Many believe, however, that they will eventually take the place of the usual forms of converters and rectifiers used on power circuits. High-pressure direct currents for transmission may some day be produced by valves. At present their advantages are only apparent when high voltages are needed.

Very little has been published on the possibilities of the thermionic rectifier, but in the April issue of the *Metropolitan-Vickers Gazette* there is an interesting article on the subject by Mr. C. T. Melling, who shows how valves may be used for rectifying single and polyphase currents. If a valve be connected to a transformer, as shown in Fig. 1, where R represents the load circuit, current flows through the valve during only one half of the cycle; that is when the plate is at a positive potential relative to the filament. If the transformer has a centre tapping—as shown in Fig. 2—then by using two valves current flows in the load circuit, driving both halves of the cycle.

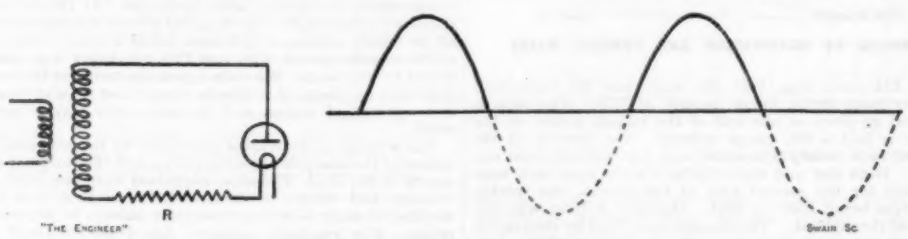


FIG. 1—SINGLE-PHASE, SINGLE-WAVE RECTIFICATION

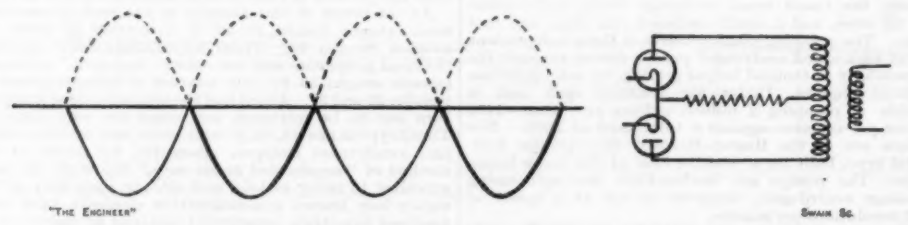


FIG. 2—SINGLE-PHASE, DOUBLE-WAVE RECTIFICATION

Three-phase alternating current may be rectified by similar means—as shown in Fig. 3—where a single wave is used. A double-wave arrangement is shown in Fig. 4, whilst Fig. 5 shows a double Y connection of the transformer. The secondary windings are connected in two stars, with a phase displacement of 180 deg., and the neutral parts are connected through a choke coil, to the centre point of which the load connection is joined. The result is equivalent to two single wave systems with the third, ninth, &c., harmonics suppressed in the load circuit.

An examination of the conditions obtaining in Figs. 1 to 5 show that in all cases except that of single-phase single-wave rectification the maximum negative voltage across the valve when no current is flowing is approximately double the direct-current load voltage, so that the valves and external circuits must have a good factor of safety. This necessitates the use of "hard" valves in order that flash-over risk may be minimised. At present, valves rated at 20,000 volts are in commission and in the near future still higher ratings will be permissible. It is chiefly at these high voltages that thermionic valves offer advantage over other types of rectifiers.

In existing thermionic valves the maximum load is of the order of a few ampères, which compares unfavourably with rotary converters and mercury-arc rectifiers. The thermionic valve rectifier is, however, able to take up fluctuations of load better than rotating machinery. Thermionic rectifiers may be worked in parallel so that the output can be increased.

While rotary converters must be designed for a particular frequency, and in general cannot be worked at frequencies higher than the commercial frequencies, thermionic rectifiers are independent of frequency and are also unaffected by fluctuation of frequency during operation.

For many purposes, unadulterated direct-current voltage is required, and resort is made to "filters," which suppress the ripples appearing in the rectified wave.

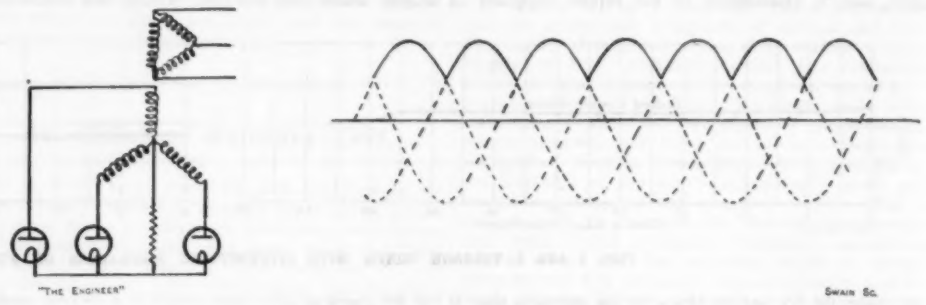


FIG. 3—THREE-PHASE, SINGLE-WAVE RECTIFICATION

The simplest filter consists of a large condenser across the output terminals of the rectifier, but this is insufficient for some purposes and combinations of choke coils and condensers are used. Such a "filter chain" can be designed to reject all ripples above a predetermined frequency.

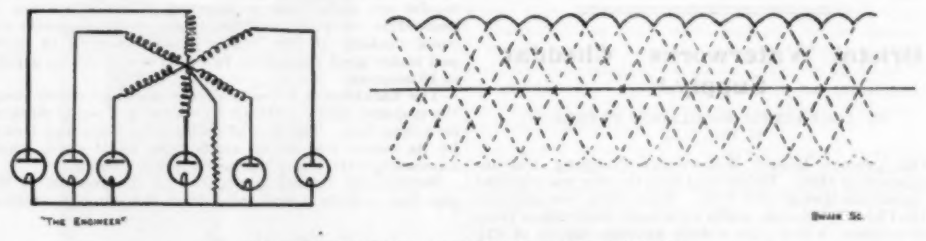


FIG. 4—THREE-PHASE, DOUBLE-WAVE RECTIFICATION

The power losses in thermionic valves are due to the power used in heating the filament, which is practically independent of the external load; and the power loss between plate and filament, which varies with the load. The power loss is independent of the rectified voltage, so that the efficiency increases rapidly with the voltage, and at high voltages the efficiency compares well with that of other types of rectifiers. There is little variation of efficiency with decrease of load.

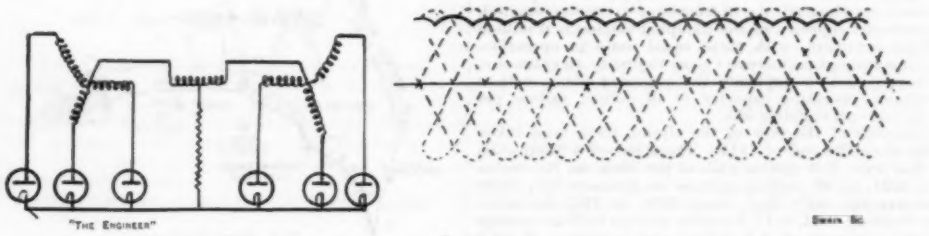


FIG. 5—THREE-PHASE, DOUBLE "Y" RECTIFICATION

The thermionic valve has a unity power factor, but the transformer with which it is used takes a slightly lagging current from the line owing to the magnetising current. Thus the power factor of the rectifier improves with load. In this respect it differs little from the mercury-arc rectifier, but is slightly inferior to the rotary converter, which, when over-excited, works with a leading power factor. On low voltages, the regulating properties of the thermionic rectifier are not so good as those of the rotary converter because of the voltage drop across the valve. On high voltages, however, the valve voltage drop is quite small, compared with the total voltage, so that change of load causes only a small change of output voltage.

In common with the mercury-arc rectifier, the thermionic type is not capable of inversion without the provision of more costly auxiliary apparatus, and when inversion is necessary, three electrode valves must be used in place of the two electrode valves. No trouble is involved in starting the thermionic rectifier.

KELVIN CENTENARY CELEBRATIONS.—To commemorate the centenary of the birth of Kelvin several interesting functions have been arranged by the Kelvin Centenary Committee for July 10th and 11th. At 4.30 on the afternoon of the 10th, at the Institution of Civil Engineers, Great George-street, Westminster, the presentation of the Kelvin Medal will be made to Dr. Elihu Thomson (U.S.A.), Sir Charles Morgan, president of the Institution, being in the chair. This will be followed immediately by the reception of written addresses from the scientific societies of the British Dominions and foreign countries. The Kelvin Oration will then be delivered, about five o'clock, by Sir J. J. Thomson. Sir Richard Glazebrook will preside at the reception of addresses and the Kelvin Oration. In the same building there will be available for the inspection of visitors an exhibit of Kelvin experimental apparatus which has been collected by the Committee specially for this commemoration. These exhibits will be on view from July 9th. An important feature of the celebrations will be a banquet to take place on the evening of Friday, July 11th, at the Connaught Rooms, Great Queen-street, W.C.2. The Earl of Balfour will preside. Tickets for the dinner will be issued in order of priority of application, the seating accommodation being limited. Those who wish to attend the banquet should send in their application to Mr. D. N. Dunlop, hon. secretary of the Kelvin Centenary Committee, 61 and 62, Lincoln's Inn-fields, London, W.C. 2.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

Unsatisfactory Situation.

CONDITIONS continue unsatisfactory in nearly all branches of the iron and steel trades in the Midlands and Staffordshire, and though a falling off in business is not unusual at this time of the year, the situation on Birmingham 'Change to-day—Thursday—was considered to be more stagnant than the seasonal relaxation warranted. The business done was without significance, except that previous evidences of market deterioration were corroborated. Uncertainty as to fuel prices encourages buyers to adopt a waiting policy and demand is small all round. Many of the works will have an extended holiday next week, and manufacturers appear to have ample supplies of material in hand for the re-starting of their plants after the Whitsuntide vacation.

A Disquieting Feature.

A disquieting feature of the pig iron department is the number of suspended deliveries, especially in connection with the Staffordshire iron trade, where the poor demand for wrought iron has brought down the consumption of forge material. For forge pig there is only the most meagre inquiry. Though there is no general revision of pig iron quotations some parcels have changed hands at less than the figures which nominally rule. On the whole, smelters are offering a stiff resistance to depreciating tendencies, backed as they are by the reaffirming of the old price for coke. The general quotation for Derbyshire No. 3 foundry still stands at £4 14s. Cases in which £4 13s. is accepted are claimed to be exceptional. Northamptonshire foundry sells at £4 11s. This figure also has been shaded in special cases. Considerable discussion centres round the fuel question, ironmasters contending that the high cost of furnace coke is one of the main obstacles to trade progress. The fixing of the price at 24s. at ovens till the end of June is a bargain which is not approved by all furnacemen, and many of them are now pressing for a reduction. Good customers have, it is said, been able to secure supplies at 23s. It is believed that a substantial fall in coke prices would give a stimulus to the trade in pig iron. Meanwhile the outlook is so dubious that consumers of this material are only buying from hand to mouth at the lowest prices they can get. In these circumstances values are indeterminate, depending very much upon the size of the order and the relationships between buyer and seller. This is particularly the case with regard to forge material.

Staffordshire Iron Trade Position.

There is very little movement to record in the Staffordshire finished iron trade. Selling prices are upheld only by production costs. The volume of business is shrinking. The marked bar mills continue well occupied, and no difficulty is experienced in obtaining the basis price of £15 per ton. Crown bars are less readily bought at £13. Nut and bolt bars command round about £12, but this section is feeling the effect of continental competition. Belgian No. 3 iron for nut and bolt making is being offered at £8 10s. delivered. The material is far inferior to Staffordshire bars, but consumers naturally make considerable use of the cheaper material. Staffordshire iron is at a disadvantage in competing with steel, owing to the relatively high price, the figure for medium wrought iron being about £2 10s. to £3 above that of welding steel. As a result the number of idle iron-making plants in the Black Country is increasing. Several well-known firms have been closed down for several weeks, and in some cases there is an inclination to make the stoppage permanent. While the great merits of the Staffordshire product are generally acknowledged, especially as regards its toughness, durability, and resistance to corrosion, users consider the disparity in price, as compared with weldable steel, too great under the present conditions of keen competition. Unfortunately, the maker cannot see his way to give his customers relief, with the result that for tube making, wagon building, and other local trades steel is being increasingly used. Most of the ironworks now re-roll bars from steel billets, which is becoming the more and more important branch of the trade.

Steel Prices.

While some branches of the steel trade are fairly busy others report a reverse state of affairs. There is a well sustained demand for plates, while sections at £9 17s. 6d. to £10 are in good demand. There is keen competition for a small volume of demand in the small steel bar branch, and many steel works this week quote £10 per ton, while in some cases £9 17s. 6d. is spoken of as a basis of negotiations. Continental competition continues to increase both as regards joists and billets, and quotations from Belgium have fallen lower, but they fail to attract much business. Nevertheless very little British semi-finished steel is being sold. Some of the large producers of billets have this week reduced their price by something like 5s. per ton in an endeavour to attract business. They are stated to be prepared to accept down to £7 15s. for their product. Against this Germany and Belgium are offering supplies at round about £7 delivered. The difference between foreign and native prices, however, is not considered sufficient to induce buying from abroad. Moreover, it is stated that buyers of Belgian steel have now to pay cash on delivery. In some cases consumers have not the orders to enable them to turn their semi-finished importations to profitable use, so that the heavy tonnages now being received on account of old contracts are causing some embarrassment.

Sheet Values.

Galvanised sheet prices have appreciated 5s. to 7s. 6d. per ton, manufacturers now quoting £17 5s. and upwards for 24-gauge corrugateds. The rise has not inspired the market with any new vigour. Mills are rather better off as regards orders, but they are able to offer deliveries in July, in some cases earlier. Buyers are not satisfied that strength of demand is responsible for the advance, and they are in no hurry to get in. Trade in black sheets is quieter, largely because the maximum demand from the motor car industry has passed for the time being. It is well known that some fairly large requirements are pending.

Scrap.

Wrought iron scrap is in fair demand, but steel scrap is a weaker market. It is obtainable in this district at £3 18s. delivered. Large consumers are taking advantage of the weak state of the market to make low offers, which, as a rule, are not acceptable.

Mines Agreement and Cannock Chase.

Industrialists in the Midlands are thankful that for the next twelve months, at any rate, there is likely to be peace in the coal mining industry. The acceptance of the new wages agreement was, of course, expected, for though certain districts were, and still are, dissatisfied, the general sentiment of the miners was clearly for acceptance. It is considered that the men should be well satisfied, for though they have not secured all they desired, the new agreement gives a solid improvement to the position of the working miner—and especially the lower-paid categories. The minimum wage is increased; the proportion of "standard" wages to profits goes up; and the division of the "pool" is altered to the men's advantage. At the end of this week the miners in the Cannock Chase coalfield will receive the increased wages arrived at under the new agreement, which will be equal to an advance of 5·66 per cent. over the present rates. The increases will be retrospective from May 1st, but whilst the current advances will, I understand, be paid this week, the back pay will be given to the men "as soon as possible," which will probably be within the next fortnight. The percentage over the basis rate is now raised from 71·78 to 77·44, and the advances in wages range from 5d. per day in the case of stallmen to a penny per day to some of the juvenile workers.

Wage Board's New Chairman.

Mr. George Hatton, managing director to Lord Dudley's Round Oak Works, has been appointed chairman of the Midland Iron and Steel Wages Board, in succession to the late Mr. George Macpherson. Mr. Hatton is a member of the Council of the Iron and Steel Institute. It is understood that the appointment has the full support of the operatives' section of the Board, which considers that Mr. Hatton has special qualifications for the position.

Ironworkers' Wages Advanced.

Ironworkers in this district are to have their wages advanced by 2½ per cent. from June 9th to August 2nd. This is the result of the bi-monthly ascertainment under the Midland Iron and Steel Wages Board, which shows an increase in selling values, and consequently, under the sliding scale which regulates iron workers' wages, carries an increase in wages to the workers. The previous ascertainment in April gave the men an advance of 5 per cent. Puddlers' wages will now be 62½ per cent. above the base rate of 13s. 6d.

Successful Wage Negotiations.

As a result of negotiations between trade union leaders acting for all the ironworkers not governed by the engineering trade conditions and awards at Staveley and Sheepbridge, Derbyshire, the wages of the whole of the workmen employed by the Staveley Coal and Iron Company, Limited, and the Sheepbridge Coal and Iron Company, Limited, have been advanced, except those in the engineering trades. The advance is of 3s. per week to day workers, and 6d. per shift to shift and piece workers.

Metal Wares Board's Proposal.

The Stamped or Pressed Metal Wares Trade Board, I learn, intends to issue a notice of proposal to increase the minimum rates effective for male workers employed as braziers, burnishers, drop stampers, dippers, and dippers who are also bronzers, annealers or polishers. The principal increases proposed for workers of twenty-one or over for a week of 47 hours are 4s. 7d. for all grade 1 men; 3s. 8d. for grade 2 braziers, burnishers or drop stampers, dippers and bronzers; 3s. 9½d. for grade 2 polishers; and 2s. 10½d. for all grade 3 men apart from polishers, who it is proposed should receive 2s. 11d. Corresponding increases are proposed for workers of the same classes who are under twenty-one.

Steel Works Wages Dispute.

The strike which last week was threatened at the Spring Vale Steel Works, Bilston, and which was to have commenced on Saturday last, has been postponed. I learn that the reason for this action on the part of the men is that negotiations are taking place as the result of which it is hoped a settlement of the wages dispute will be arrived at. At the time of writing negotiations between the men's leaders and representatives of the firm were still proceeding.

Worcester Firm's Tender.

It is reported in Birmingham that an offer by Heenan and Froude, Limited, of Worcester, to erect a new refuse destructor plant for the city of Glasgow at a contract price of £382,000, has been recommended for acceptance.

Unemployment.

The unemployment returns for the Midlands area have this week again turned in the right direction, but the decrease of 422 on last week's figure of 120,674 still leaves 209 workers to be re-absorbed into Midland industries before the figure of 120,043, recorded on May 12th, is returned to. There are now unemployed in the area 86,603 men, 2048 boys, 28,459 women, and 3142 girls. Of the total 30,807 are in the Birmingham area, 2334 in Coventry, 6009 in Wolverhampton, 2728 in Bilston, 4380 in Cradley Heath, 3850 in Dudley, 1681 in Oldbury, 4271 in Smethwick, 3176 in Stourbridge and Brierley Hill, 5312 in Walsall, and 2966 in West Bromwich.

LANCASHIRE.

(*From our own Correspondents.*)

MANCHESTER.

General Outlook.

THERE has been no sign of improvement in the local markets for iron and metals this week, and as nearly the whole of next week will be given up to holiday making, it is fairly clear that those people were right who, early in May, told us that there was no chance for any movement until after Whitsuntide. One is now, however, inclined to believe that we must postpone any favourable expectation to a much later period, possibly to the autumn, but more probably to the spring of next year. This will allow for nearly seven years after the Great War was brought to an end, and there is certainly a chance that its terrible effects upon the industries of the whole world will then begin to pass off. There have been reports here lately of some little improvement in foundry work and in general engineering; but so far these reports are vague, and one fears that they are not generally true, but apply to merely individual cases. One does not find any indication amongst merchant firms that business is any brighter, and if there had been any general movement in either foundry or engineering work the merchants of the district would certainly have felt it.

Copper.

The market for copper, after having shown a little improvement in prices, seems inclined to slip back again. There would seem to be still far too much anxiety on the part of American producers to sell copper so soon as there is the slightest upward tendency, and this is very disconcerting. It seems to point to an opinion amongst producers that the time for a general advance in values is yet a long way off. One cannot see that it can be very profitable, even for favourably situated works, to sell American copper at present prices; but, of course, they do not want it to accumulate. The tendency to reduce the output of copper in America is still in evidence, and this should help to keep stocks from becoming unwieldy. Hence one cannot see much probability of any serious fall below the present level of prices, even if trade remains quiet for the remainder of the year. The local demand for ingot copper is only small, but the placing of a considerable number of locomotive orders ought to be a good thing for makers of tubes. The price for brass locomotive tubes is now 1s. per pound. In the scrap metal market dealers here continue to offer only very low prices, and evidently are afraid of increasing their stocks. Gun-metal scrap especially can be bought at favourable rates, for several dealers here are now offering to pay only £44 per ton for it. Selling prices, of course, vary a good deal with the opinions of the dealer. But the metal can now be secured by consumers on very favourable terms. In the tin market prices are still very variable, but there is a slowly growing feeling that prices are not going below the £200 level. There has been some quiet buying at each time of "set-back," and this is thought to be done by "people who know." Of course, this is conjecture, but it is well to remember that the probable extent of a fall, as of a rise, is always exaggerated. When the market was advancing this exaggeration took the form of predicting £500 per ton for tin; now it takes the form of predicting £150 per ton. One has a suspicion that shrewd operators are now getting in whenever the price goes near to £200. The market for lead has been stronger again, and practically the whole of the loss which occurred in the first three weeks of May was recovered in the last week. Perhaps one reason for this was the failure of the expected supplies of Mexican lead. This, however, may come in later, as North America does not now seem likely to buy lead from that source. Spelter has participated in the better feeling in lead, but there has been no substantial advance in prices, and ordinary brands of spelter are to be bought at near the price of foreign lead. The demand from the galvanisers has, however, been rather better lately.

Pig Iron.

The demand here for foundry iron is now only of a retail character, as no more serious buying is at all likely to take place until after the holidays. A few small orders are heard of and the price being paid for delivery in Manchester is usually 101s. 6d. per ton for No. 3 Derbyshire. Most sellers of Derbyshire iron now base the price on 94s. at the furnaces, but some still hold out for 95s., and one does not hear that they are now getting any business. Of course, the demand is so small this week that there is no need to pay the higher price unless the buyer will have a particular brand. One hears of quotations as low as 93s. at the Derbyshire furnaces, but this is not yet a regularly established price. The market is, however, weak, and seems inclined to get weaker; but it is not perhaps quite fair to dwell upon this weakness, because it may be merely the result of the approaching holiday. We should be better able to judge whether any permanent weakness has set in after the end of next week. Certainly furnace coke is easier, but blast-furnace owners do not admit that they can buy Midland coke under 24s. per ton, and at that price it is unprofitable to sell pig iron at less than 93s. at the furnaces. Northamptonshire No. 3 pig is quoted at 91s. at the furnaces, but it is no cheaper for the Manchester ironfounder than Derbyshire at 93s. 6d., and very little of it now comes into this market. East Coast hematite iron is easy and can be bought here at 110s. 6d. per ton, or, say, 9s. above the price of common iron, whereas the makers' prices for Scotch iron in Man-

chester are fully 116s. 6d. per ton. It is rather curious to have hematite iron at 6s. per ton less than Scotch.

Steel.

One can find no sign of improvement in the general steel trade. There were some foreign steel billets on offer here this week at £6 10s. to £6 12s. 6d. per ton delivered, but in spite of the fact that they are so much cheaper than British semi-steel, no one seemed anxious to buy. Merchants and agents are still quoting £9 10s. in Manchester for joists and angles, and plates can be bought here at £10 2s. 6d. and perhaps at £10 per ton. Foreign sections are about £1 per ton cheaper than British in this centre, but one does not hear that much business is being done in them. Buyers are still nervous as to the delivery. Flat bar steel is quoted at £10 to £10 5s. for British makes.

Scrap.

There is practically no change in the position of scrap this week, except that holders of foundry scrap seem to be a little firmer than they were. Some dealers are holding out for 92s. 6d. per ton for really good lots of broken machinery metal, but this class of scrap can be bought at 90s. As pig iron is now at 101s. 6d.—perhaps 101s.—the difference between scrap and pig is less than it was; but, of course, the prices are not nearly so close together as they used to be in more normal times.

The Vulcan Foundry, Newton-le-Willows.

The members of the Manchester Association of Engineers paid a visit to the works of the Vulcan Foundry, Limited, Newton-le-Willows, on the 29th ult. The president of the Association, Mr. H. Bates, M.I. Mech. E., and 130 members attended. The visitors on arrival were received in the works institute, and were shown round the extensive works in parties by Mr. F. S. Whalley, the general manager, and his staff. These works were established in 1830 by Charles Tayleur, who was subsequently joined in partnership by Robert Stephenson until his appointment as engineer of the London and Birmingham Railway. In 1864 the concern was turned into a limited company, when Mr. W. F. Gooch became general manager, being succeeded in 1892 by Sir William Collingwood, the present managing director. Mr. R. P. Richards was appointed general manager in 1917 and was succeeded, on his joining the board of directors, in June, 1923, by Mr. F. S. Whalley, M.C., the present general manager. Since the inception of the firm its activities have been mainly confined to the designing and building of locomotive engines, and Vulcan locomotives are now running in most parts of the world. The company has just completed an order for twenty large goods engines and tenders for the Bengal Nagpur Railway, and is now commencing the delivery of twenty tank locomotives for the London, Midland and Scottish Railway (Derby section). One of these tank locomotives was seen under steaming test during the visit. Amongst other orders in hand are four engines and tenders for the Crown Agents for the Gold Coast Railways, forty heavy passenger engines and tenders for the East Indian Railway, twenty boilers for the Great Western Railway, and fifty boilers for the London, Midland and Scottish Railway (Crewe section). The works are at present employing about 1500 hands, but when engaged to their full capacity they find employment for 2500 persons. At the close of the visit tea was served to the visitors and a vote of thanks was accorded to the Vulcan Foundry Company for the privilege which had been afforded to the Association.

The Engineers' Club.

A simple but very impressive little ceremony was performed in the Joule Room of the Engineers' Club, Manchester, on Tuesday last, when the President, Mr. John Taylor, C.B.E., unveiled the tablet containing the names of the ten members and staff who were killed during the Great War. Mr. Taylor made a few very appropriate remarks on the relationship of the engineers to the fighting forces. He said that in spite of the fact that expert engineers were not permitted in most cases to join the Army, no less than seventy-one members of the Club did so, and of them, many had earned high military distinctions. The dedication service was subsequently performed by the Dean of Manchester, the Very Rev. J. G. McCormick. The memorial takes the form of a bronze tablet, about 4ft. high by 2ft. 6in. wide, on which an appropriate design forms a framework for the names of the heroes. The only inscription on the tablet is: "In Memoriam, 1914–1918." The design and execution of the tablet were both carried out by Mr. James Smithies.

BARROW-IN-FURNESS.

Hematite.

We are still waiting for evidences of an improvement in the hematite pig iron trade. Customers are still holding back, and such orders as are being placed are for immediate requirements. The output of iron is not great, but this is due mainly to the fact that the steel departments are taking very little iron owing to lack of life in the steel trade. The Barrow furnaces are still idle, but it is likely that they will re-start in a few weeks, although there is nothing definite as yet. If there was a better outlook in the steel trade and if more orders were available the Barrow works would have been engaged weeks ago. The amount of trade with the Continent and America is not much at present, and with the depreciation of the franc the prospect of better trade with France and Belgium is not bright. The Midlands are taking a fair proportion of the iron from this district. Scottish buyers are not very keen. Inquiries are being received, but the amount of business resulting is not heavy. There were considerable stocks in the district of pig iron, but these have been reduced during the past few weeks. Really the iron trade in this district requires more confidence in the market generally, and a marked improvement in the steel demand before it improves.

Iron Ore.

The local iron ore trade is poor and some of the mines are idle. This condition of affairs will continue until the iron trade improves, and when that will be is difficult to say. The same remark applies to the foreign ore business, which is far from brisk. Imports are restricted, naturally.

Steel.

The steel trade is very quiet, and what orders are in the market are keenly competed for, with resultant cutting. Both steel works in the district have orders on hand, but not sufficient to keep them going for any time, and difficulty is experienced in securing other contracts to make the re-starting worth while. The hoop and small section mills at Barrow are better circumstanced, for they have orders which keep them regularly employed.

Shipbuilding and Engineering.

Shipbuilding and engineering is better than it has been for two years. On the shipbuilding side many vessels are in course of construction, and preliminary work is proceeding in connection with the 10,000-ton cruiser. In the engineering shops there is much activity. The boiler and pattern departments have not been so busy for a considerable time, and difficulty is experienced in obtaining sufficient hands. Many skilled men who left for America last year and the year before are coming back to their homes now that the prospects of work are better. Some report that work is available in the States provided there is influence at that end to secure it. Unemployment, they say, is not unknown out there, and in many cases the increased earnings are more than balanced by the conditions which prevail.

SHEFFIELD.

(From our own Correspondent.)

Reaction in Semi-finished Steel.

THE reports which I have been sending for the past few weeks as to the falling off in the demand for basic steel have this week to be repeated, with emphasis. It is now apparent that there is a reaction in regard to crude iron and steel. Towards the end of last year a considerable improvement set in, which was maintained during the first quarter of this year. The big open-hearth furnaces of the district were well employed, and the great plant at Templeborough, consisting of fourteen furnaces, was able to keep nine of them in commission, the largest proportion it had ever known. But during the past two months there has been a serious decline of business—in fact, that period has scarcely seen the placing of a single contract of importance for common basic billets in the district. The work on hand is being rapidly completed, and makers are finding it necessary to reduce production. The figures of iron and steel production in the country showed a falling off in April as compared with March, and the returns for May will no doubt reveal a further shrinkage. In Lincolnshire, the iron and steel works have enjoyed great activity for something like three years, but they are now beginning to experience a change, and one fairly large establishment has been idle for nearly a month. The condition of the acid steel branches is better than that of the basic, as a large quantity of material is called for in connection with the railway orders that are on hand, but even in these departments there is not sufficient work to insure full employment.

The Finished Trades.

Most of the finished branches report a fairly brisk trade, but prices remain low, and there is a general complaint of absence of profit. Orders from the engineering works show an increase, but progress is very slow, and not much demand exists for twist drills and cutters of various kinds. A capital trade is still being done in saws, and another active branch is the making of machine knives, of which a considerable quantity is being sent abroad. The file trade maintains the improvement which it has been showing for the last twelve months, but it still requires a lot of work to make it really busy, and, although prices are no longer as severely cut as they were, makers declare that profits are still on a very small scale. The building trade is calling for good supplies of tools, makers of which are able to dispose of their full output. As a result of the housing schemes, too, there is a large inquiry for fireplaces and ranges of new designs suitable for small dwellings. Stainless steel is now applied to various household fittings, including register grates, kerbs, fire-irons, stair rods, and curtain hooks, but the demand grows only slowly in consequence of the high cost. There is a good deal of activity in the wire trade, which is supplying large quantities of material to makers of ropes and cables, as well as for fencing purposes.

Cutlery and Plate.

There is no change to report in the condition of the cutlery and plate industries. The demand for stainless table knives is still very large, but it relates chiefly to the cheaper qualities, and firms which turn out only the best classes of goods are poorly employed. The razor trade shows some improvement, and a very cheering bit of news of the week is the placing of an order, with one of the best-known firms in the city, for 2000 dozen of these articles for overseas. In the plate branch, the chief call is for spoons. Various other articles, of the cheaper sorts, are selling fairly freely, but the trade in high-class hollow-ware is very dull.

Progress of Thorne Colliery.

The new colliery at Thorne, near Doncaster, at which sinking operations have been in progress for a considerable time, is now getting on very well. The enterprise belongs to Pease and Partners. Sir Arthur Pease, speaking at the annual meeting of the company last week, announced that the No. 1 shaft had now reached a depth of 818 yards, and that it was expected that the Barnsley seam of coal would be reached 100 yards further down. There was nothing to prevent their completing that distance by September next, and it was hoped that the second shaft would be down 15 months later. In the latter shaft, they had just got through the alluvial deposit and on to the limestone, and it was beneath the limestone that they struck coal in the first shaft. The sinking costs at Thorne have been very heavy, but happily a good deal of the work was done before the war, otherwise the outlay would have been much heavier still. The colliery is to be a very large one, as was shown by Sir Arthur's remark that eventually an output of from 1¼ to 1½ million tons per annum was expected. He added that it would take about ten years to reach that maximum, but that, as soon as the further preliminary work had been completed, the amount of coal sent to the surface ought to increase very rapidly.

Other Colliery Developments.

Another piece of definite news with regard to progress in the opening up of the Doncaster coalfield comes from Markham Main. It is only a few weeks since I reported that the sinkers had reached the Barnsley bed in the No. 1 shaft at a depth of 730 yards. They have now struck the same seam in the second shaft at a distance of only 1 yard further down. Now that both shafts have reached coal, headway will soon be made in opening up the new colliery. Eventually, from 3000 to 4000 men will be employed there. There are signs of an early start being made with the sinking at Awkley, the latest enterprise of the directors of the Markham group of collieries. Machinery and equipment used in the sinking at Armthorpe, not far away, are now being transferred to the new site. There is a probability of the early reopening of the Barnsley pit of the Rotherham Main Colliery, which has been closed for upwards of two years. The owners have carried out improvements in the workings, in order to facilitate the getting of coal, and have offered the men a new price list, which is now under negotiation.

Vickers and Howden.

A good deal of curiosity has been expressed at different times as to the fate of the great aerodrome at Howden, in East Yorkshire. It is now reported that Vickers Limited have secured it for the carrying out of a Government contract in connection with the construction of a new airship. It is stated that a good deal of the stores have been taken over with the property. The people of Howden are looking forward with interest to the further development of the area.

Sheffield's New Waterworks.

With a view to meeting its future water needs Sheffield has for some years been carrying out the construction of two large new reservoirs in the Ewden Valley, between the city and Penistone. Good progress has now been made with the work, which was begun in 1913, but had to be suspended between 1915 and 1919 owing to the war. The two reservoirs have reached an advanced stage of construction, and it is anticipated that they will be completed and ready for service in two or three more years. The Broomhead reservoir will have an area of 115 acres, and a capacity of 1050 million gallons; while the More Hall Reservoir will cover 70 acres and will hold 562 million gallons. The two reservoirs will receive the daily flow from a drainage area of 6496 acres. The average daily quantity is estimated at 7,249,536 gallons, of which, after deduction of compensation water, 4,620,163 gallons will be available for supply to the city and district. A pipe line, seven miles in length, will convey the water from the reservoirs to a service reservoir at Wadsley, which has recently been completed. The total cost of the works is estimated at about £1,500,000. Up to the present, the expenditure has amounted to £835,000.

NORTH OF ENGLAND.

(From our own Correspondent.)

Iron and Steel Exports.

THE outstanding feature of the export returns of pig iron and manufactured iron and steel for the Cleveland district during May is the fact that the total tonnage was the biggest recorded for over ten years. This result may appear somewhat astonishing in view of the generally lean time experienced by producers during the past month, but most of the business was put through in the latter part of April, when the violent fluctuations of the franc caused a swift change in the normal flow of trade. When the franc stood at 63 to 66 to the £ Cleveland iron was the cheapest in the world. Not only were French and Belgian producers unable to compete in the near European markets, but they were actually undersold in their own countries. As a result the May shipments of Cleveland pig iron reached the gratifying figure of 66,659 tons. This total, however, was slightly exceeded in March of last year. Germany was a big customer, taking in all 10,788 tons, and Belgium took 10,282 tons, although much of the iron shipped to Antwerp was destined for countries other than Belgium. To these countries, however, the exports were the biggest of any month's this year, and this remark also applies to the 8900 tons shipped to Norway and Sweden and the 5367 tons to France. Although 7290 tons were shipped to Italy, this figure was slightly exceeded in January last, and the Scottish shipments amounting to 10,173 tons fell 1790 tons short of the April total. Notwithstanding the keen competition in the manufactured iron and steel trade of the world, Cleveland manufacturers exported 68,635 tons last month, a figure which has not been exceeded since November last. The greatest bulk of the trade was done with British Dominions, India, Burmah, and Ceylon accounting for 21,969 tons, Australia and New Zealand 9770 tons, and South and East Africa 6799 tons. Amongst other territories most profitable business was done with the South American Republics, to which 9154 tons of iron and steel were shipped.

The Outlook.

Unfortunately, the future prospects for the export trade are anything but encouraging. During the past week or two the whole position has changed as a consequence of the financial crisis in Germany and the relapse of the franc. Cleveland producers are once more shut out of the near European markets. France and Belgium are again successfully competing, and the whole system of international finance has become so unstable that in markets in which British manufacturers might hope to do business consumers are holding off until the outlook is less obscure. Indeed, the future is being viewed with some anxiety, as the ensuing two or three months are usually also a slack time for the home trade.

Cleveland Iron Market.

The prevailing quietness in the Cleveland pig iron market has been accentuated this week by the near approach of the Whitsuntide holidays. The market is extremely dull and depressed, and it is very difficult to fix prices. Makers are willing to bargain for orders having regard to the size of the contract offered and other conditions. Thus whilst some of the makers still quote 91s. for No. 3 Cleveland pig iron, it is understood that 90s. per ton would be accepted for a decent order. No. 1 foundry iron might be obtained at 95s., No. 4 foundry at 98s. 6d., and No. 4 forge at 89s.

Hematite Pig Iron.

Quiet conditions also prevail in the East Coast hematite pig iron trade. The demand has fallen away to a disappointing degree. There is no foreign business to be done, and very little with home consumers. The trade is, in fact, badly in need of a fillip, and although there is no talk yet of stopping more blast-furnaces, that is a contingency which is bound to arise if the market does not soon improve. Mixed numbers are quoted at 98s. per ton and No. 1 at 98s. 6d., but a good order could be placed at sixpence less.

Ironmaking Materials.

The foreign ore trade is absolutely lifeless. With the iron trade outlook so uncertain, consumers are not prepared to commit themselves, and there is positively no business to test the market. Best Rubio ore is nominal at 23s. 6d. per ton c.i.f. Tees. Coke is also weak and 28s. per ton is now a full price for good medium furnace qualities delivered at the works.

Manufactured Iron and Steel.

The manufactured iron and steel trade presents no new features. There is a distinct lull in the inquiries for new shipping, and the ship repairing industry has seldom been so slack. All these facts react upon an already depressed steel trade, and there are general complaints of a scarcity of orders. A better demand for galvanised sheets is the one bright spot. Prices are unchanged.

The Coal Trade.

No improved tendency is noticeable in the Northern coal trade and the outlook is anything but encouraging. Indeed, the generally stagnant condition of the market is worse than has been experienced for some years, and as a consequence some of the collieries are idle and others working short time. Coal fitters are hard up for trade and the difficulty of keeping the pits working is becoming increasingly hard. From no continental centres is any bright spot discernible, and apparently the only check to prices slumping further is that producers decline any lower figure and will close down rather than continue at uneconomic figures. It is pointed out, however, that the slackness of demand is not a question of price, but of consumers' inability to make use of the coal through idle factories, &c. Northumberland steam coals are very slow, but producers decline to make further concessions. Prime gas coals are steady, but all other classes of Durham coal are weak. The coke trade remains dull and stocks are in excess of requirements, with the result that many ovens have been put out of operation.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

THE output from the Clyde shipyards during the month was the second largest for that month since the end of the war, and amounted to 38 vessels of 44,390 tons aggregate. Of the number launched, however, only four are over 4000 tons measurement. Apart from a number of smaller cargo, cargo-passenger and passenger steamers, the majority of the craft launched consisted of small pleasure boats. The principal launches were:—The Takliwa, twin-screw passenger and cargo, 9200 tons, for the British India Steam Navigation Company, Limited, London; Silurian, twin-screw motor ship, 7000 tons, for Owen and Watkin Williams and Co., Cardiff; Mariston, cargo steamer, 4600 tons, for W. S. Miller and Co., Glasgow; and the Alara, cargo, 4100 tons, for the Adelaide Steamship Company, Limited, Australia. The outlook is brighter, but has one or two unsatisfactory features. Builders are still fixing contracts at prices which may clear costs, but will leave a very bare margin of profit, if any profit at all. Competition is keen, and costs have to be kept as low as possible. New contracts recently reported include the following:—Messrs. Beardmore, a 22,000 tons liner for the Lloyd Sabaudo of Genoa; the Blythswood Shipbuilding Company, a motor tanker of 13,000 tons, for Mr. Knut Knutsen, of Haugesund; Messrs. Alex. Stephen and Sons, a cargo steamer of 8250 tons, for Messrs. Maclay and M'Intyre, Glasgow; and the Fairfield Company, a large motor oil tanker for the Houlder Line, Liverpool. The Caledon Shipbuilding and Engineering Company, of Dundee, is to build a twin-screw motor tanker of 10,900 tons for the Puro Cane Molasses Company; and the Burntisland Shipbuilding Company two cargo steamers of 4000 tons, for the Pentwyn Steamship Company, Cardiff.

Labour Affairs.

The dispute which arose a week or two ago at the Blochairn Steel Works has been settled. The notice putting the plate mill loading bank on a contract system has been withdrawn, and it has been agreed that any question relating to conditions of the plate mill loading bank shall be referred to a joint committee of both sides. Trouble has arisen at the Loanend Colliery, Cambuslang, owing to the underground firemen and certificated shot-firers, who are members of their own union, refusing to join the miners' union. The latter has declared a stoppage until the firemen come into line. The firemen contend that their own organisation is a registered trade union, and that they are members of the British Firemen's Federation, which is affiliated to the Trades Union Congress. It is stated that outside Scotland there are fourteen associations in the British Firemen's Federation, with a membership of 18,400, and that no attempt is made by miners' officials in England and Wales to compel the firemen to join the miners' union. It is further stated that the firemen's representatives have endeavoured, without success, to have the position discussed, and that no later than Friday of last week a personal appeal was made by the firemen's secretary to the miners' agent at Loanhead, which was also met with refusal. The company states that instructions from the Coalmasters' Association prevents it interfering, so that the position at present is one of complete deadlock.

Steel and Iron.

The position in the steel and iron trades is without alteration. Forward buying is almost at a standstill, and purchases for immediate consumption are light. The tone of the market keeps remarkably firm, however, makers being evidently confident that orders will ere long come through unless the continental competition, which has again become apparent, becomes more intense. Steel plates are very slow to move, and a considerable portion of the producing plant is unoccupied. The demand for sections is not quite so poor as for plates. Sheets are quiet, but an improving tendency is noticeable in export. Bar iron has a very small turnover, and here also mills are working far below capacity. Re-rolled steel is a shade brisker. Pig iron for home consumption has a small market. Stocks continue to accumulate, but it is said that some good shipping orders for hematite have been placed of late. No change in prices has been announced.

Coal.

The demand for coal continues disappointing, and the market has been dull and lifeless. Business has been difficult to negotiate, and neither foreign nor home buyers can be induced to indulge in forward buying to any extent. In order to effect a clearance of colliery sidings a considerable quantity of cheap fuel has been offered, but little success has attended such efforts. Idle time is fairly general. Round coals in particular have been difficult to dispose of, washed nuts being steady in comparison. Prices have been irregular, but latest advices seem to indicate a steadying tendency. Aggregate shipments amounted to 287,053 tons, against 296,192 tons in the preceding week, and 307,610 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

CONTRARY to the usual experience, the conditions in the coal trade are very quiet, whereas loading pressure is generally looked for immediately before the holidays. In the early part of this week there were about a dozen loading berths idle at the various docks. Under normal conditions the experience would be for ships to be waiting in good numbers and everybody doing their utmost to sail them before the holidays. For vessels to have to wait until the holidays are over is an expensive matter, as the official holidays in the coalfield will be the first three days of next week, while it has also been arranged that there shall be no work at the docks on Monday and Tuesday next. Generally speaking, there is not much life in business at the present time, and it is undoubtedly the case that uncertain labour conditions are proving highly detrimental to operations. No sooner is one trouble surmounted than there is an outbreak in another direction. It is, of course, very gratifying that the coalowners and the miners' leaders have come to an agreement, and the majority which was obtained for that course at the national conference of the Miners' Federation last week came somewhat as a surprise. At the same time it is felt that the period of the new agreement, viz., twelve months, with a month's notice to terminate same, is too short. Settled conditions would have been preferred for a longer period. Now there is the threat of a stoppage on the part of the shopmen employed by the Great Western Railway Company, while it was understood that preparations were being made to get the power-house men in this district and the dock and marine men to come out in support of their demands, which include an advance of 10s. per week, which amount was deducted from their wages in October last. The fact that the movement is officially condemned by the N.U.R. executive is perhaps responsible for the apparent indifference which is displayed towards the threat of a strike, while the additional fact that it comes practically at a holiday time and that it is difficult to say what may be the effect upon coal shipment operations, if indeed there is any, may explain the absence of real anxiety on the part of those interested in the trade.

Sectional Strife in the Coalfield.

The trouble which has been experienced in the Monmouthshire area, and particularly in the Sirhowy Valley, looks promising for coming to a complete termination shortly. In the case of the strike of the men at the Nine Mile Point and Risca collieries, where about 3500 workmen have been idle for about a fortnight, the rank and file have taken matters into their own hands, and at the end of last week there was a mass meeting of the miners when they decided to resume work at the earliest possible moment. This decision was arrived at in direct opposition to the advice of the local lodge officials, who were strongly in favour of continuing the struggle. The officials naturally regarded this action as tantamount to a vote of no confidence and consequently resigned, since which a new set of officials has been appointed. It was expected that full resumption of work would be made on Wednesday of this week. As regards the stoppage of work on the part of 14,000 miners in the Sirhowy Valley as the result of the dispute at the Markham Colliery, the officials of the South Wales Miners' Federation had an interview with the Tredegar Combine executive on Monday, and on Tuesday the matter came up for consideration at a meeting of the Joint Disputes Committee, when it was arranged that the miners should also resume work on Wednesday of this week. There are to be further negotiations locally on the point in dispute.

Rhondda Rumblings.

The Rhondda district threatens to be the centre of labour disturbance on account of the action of the Rhondda No. 1 Council of the Miners' Federation respecting the non-unionist question and also in support of the workmen of the Ynysfaio Colliery, Treherbert, numbering about 1400, who are on strike as a protest against the introduction by the management of the double-shift system. If the threat matures then about 30,000 miners will be affected. About 10,000 men are idle at the Rhondda Fach pits of D. Davis and Sons, Limited, on account of the destructive fire of the power station near Tylerstown; but on Tuesday the men employed by this company decided upon strike action in sympathy with the Ynysfaio miners, subject to the approval of the Rhondda No. 1 district. They also threaten strike action in order to enforce the removal from office of three firemen, who, they allege, failed to report the presence of gas in the workings. The management recently suspended the officials in question pending an inquiry, but subsequently reinstated them.

Power Station Disaster.

The well-known colliery company, D. Davis and Sons, Limited, sustained a severe loss on Thursday evening in last week, when its power station near Tylerstown was destroyed by fire. Damage variously estimated at from a quarter to half a million pounds was done. The outbreak followed upon flashes of lightning, though it is impossible to say what was the cause of the disaster. The station was built in 1907 and was generally considered to be one of the finest plants of its kind in the country. Eight of the collieries owned by the company were almost entirely dependent for power from it, and the ninth colliery drew upon it to a large extent. About 10,000 men were immediately rendered idle, but the management at once set to work to make temporary provision for power and provided certain material was delivered as promised, the general manager was hopeful of resuming work on Tuesday night's shift of this week at four of the Tylerstown collieries, so as to give employment to about 5000 men.

Current Business.

The demand from abroad has been very quiet during the past week and market conditions have altogether been somewhat depressing. Many collieries must be experiencing great difficulty in maintaining regular work at their pits, as the loading pressure at the docks is not heavy. Best Admiralty large coals remain about 28s., which is the figure quoted by the collieries direct, though exporters find it almost impossible to do business with foreign consumers at this price. Second qualities are about 27s. to 27s. 6d., but dry coals are quiet and there is no appreciable demand for Monmouthshire descriptions. Small coals continue to be steady on the basis of 18s. to 18s. 6d. for the superior grades. Patent fuel quotations are unaltered. The Phœnix patent fuel works at Swansea, which have been closed down for several weeks past, have been reopened. In the case of the anthracite section sized coals are a shade firmer, but duff coals are in good supply and are not moving off freely.

Latest News from the Provinces.

WALES AND ADJOINING COUNTIES.

Tin-plate and Bar Prices.

THE Stabilisation of Prices Committee in the tin-plate and Siemens steel bar trade has reduced the minimum price of tin-plate bars by 6s. 3d., thus making the price £8 12s. 6d. per ton f.o.b. Bristol Channel ports, less 7s. 6d. per ton rebate to tin-plate works in the prices scheme. In the case of tin-plates, the minimum price has been brought down from 23s. 6d. per basis box to 22s. 7½d. f.o.b. works port. It is stated that the reduction is due to shortage of orders for early shipment and the falling off in the price of tin.

Tylerstown Pits.

As the result of the energetic action on the part of the management of Davis and Sons, Limited, whose power station was destroyed by fire last week, 2000 men resumed work at two pits on Tuesday night, and 3000 at two pits on Wednesday night. Work will not be restarted at four other pits in the Ferndale district, where about 5000 men are employed, until about the 12th inst., as it is necessary for the management to install another high-pressure transformer for these pits.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	17/6 to 24/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	23/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(3) SCOTLAND—		
Hematite	5 2 6	—
No. 1 Foundry	5 5 0	—
No. 3 Foundry	5 0 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 18 0	4 18 0
No. 1	4 19 0	4 19 0
Cleveland—		
No. 1	4 15 0	4 15 0
Silicious Iron	4 15 0	4 15 0
No. 3 G.M.B.	4 10 6	4 10 6
No. 4 Foundry	4 9 6	4 9 6
No. 4 Forge	4 8 6	4 8 6
Mottled	—	—
White	—	—
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	9 2 6	—
North Staffs. Forge	4 7 6 to 4 10 0	
" " Foundry	4 15 0	—
(3) Northampton—		
Foundry No. 3	4 11 0	—
" Forge	4 5 0	—
(3) Derbyshire—		
No. 3 Foundry	4 14 0	—
Forge	4 7 6	—
(3) Lincolnshire—		
No. 3 Foundry	4 14 6	—
No. 4 Forge	4 13 0	—
Basic	4 11 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	5 12 6 (a) / 5 17 6 (b)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	12 10 0	—
Best "	—	—
N.E. COAST—		
Common Bars	12 10 0	—
LANCS.—		
Crown Bars	13 0 0	—
Second Quality Bars	12 0 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	13 0 0	—
Best "	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	13 0 0	—
Marked Bars (Staffs.)	15 0 0	—
Nut and Bolt Bars	12 0 0	
Gas Tube Strip	13 5 0 to 13 7 6	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	13 10 0	—
Ship Plates, ¾in. and up	10 5 0	—
Sections	10 0 0	—
Steel Sheets, 3/16in. to ¾in.	12 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	17 5 0

STEEL (*continued*).

N.E. COAST—	Home. £ s. d.	Export. £ s. d.
Ship Plates	10 5 0	—
Angles	10 0 0	—
Boiler Plates	13 10 0	—
Joists	10 0 0	—
Heavy Rails	9 0 0	—
Fish-plates	13 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	10 5 0	—
Soft Billets	9 0 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 5 0†	—
Light "	9 10 0 to 10 0 0†	
Billets	8 10 0 to 12 0 0†	
MANCHESTER—		
Bars (Round)	10 5 0 to 10 15 0	
" (others)	10 0 0 to 10 2 6	
Hoops (Best)	15 5 0	15 0 0
" (Soft Steel)	13 15 0	13 10 0
Plates	10 0 0 to 10 5 0	—
" (Lancs. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	12 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	10 5 0	—
Intermediate Basic	10 0 0	—
Soft Basic	8 15 0	—
Hoops	12 10 0 to 13 0 0	
Soft Wire Rods	11 0 0 to 11 10 0	
MIDLANDS—		
Small Rolled Bars	10 0 0 to 10 10 0	
Billets and Sheet-bars	7 15 0 to 8 0 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 5 0	
Angles	9 17 6 to 10 0 0	
Joists	9 17 6 to 10 0 0	
Tees	10 17 6 to 11 0 0	
Bridge and Tank Plates	10 10 0	—
Boiler Plates	14 0 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	22/7½ to 22/10½
Block Tin (cash)	209 12 6
" (three months)	208 17 6
Copper (cash)	61 15 0
" (three months)	62 15 0
Spanish Lead (cash)	30 15 0
" (three months)	28 12 0
Spelter (cash)	31 0 0
" (three months)	31 2 6
MANCHESTER—	
Copper, Best Selected Ingots	69 10 0
" Electrolytic	69 0 0
" Strong Sheets	94 0 0
" Tubes (Basis price)	0 1 1½
Brass Tubes (Basis price)	0 1 0
" Condenser	0 1 2½
Lead, English	33 0 0
" Foreign	31 5 0

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/8½ per lb.	
Ferro Tungsten	1/4½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	10/6
" 6 p.c. to 8 p.c. "	£23 10 0	8/-
" 8 p.c. to 10 p.c. "	£23 0 0	8/-
" Specially Refined		
" Max. 2 p.c. carbon	£42 10 0	16/-
" " 1 p.c. "	£51 0 0	17/6
" " 0.75 p.c. carbon	£68 0 0	20/-
" carbon free	1/5 per lb.	
Metallic Chromium	4/2 per lb.	
Ferro Manganese (per ton)	£17 for home, £17 for export	
" Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- per unit	
" " 75 p.c.	£18 0 0 scale 6/- per unit	
" Vanadium	19/3 per lb.	
" Molybdenum	8/3 per lb.	
" Titanium (carbon free)	1/3 per lb.	
Nickel (per ton)	£135	
Cobalt	10/6 per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.

LANARKSHIRE—	Export.
(f.o.b. Glasgow)—Steam	18/-
" " Ell	19/6
" " Splint	20/6 to 23/-
" " Trebles	20/6
" " Doubles	20/6
" " Singles	18/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	18/-
" " Splint	20/6
" " Trebles	20/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	19/6 to 22/-
Screened Navigation	27/6
Trebles	21/-
Doubles	20/9
Singles	17/- to 18/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	19/-
Secondary Steam	18/-
Trebles	21/3
Doubles	21/9
Singles	18/-

ENGLAND.

(8) N.W. COAST—	
Steams	32/-
Household	49/- to 59/-
Coke	35/-
NORTHUMBERLAND—	
Best Steams	21/6 to 22/-
Second Steams	20/- to 21/-
Steam Smalls	13/6 to 14/-
Unscreened	18/- to 20/-
Household	27/-
DURHAM—	
Best Gas	23/- to 23.6
Second	20/6
Household	27/-
Foundry Coke	26/- to 28/-
SHEFFIELD—	Inland.
Best Hand-picked Branch	34/- to 35/- —
Barnsley Best Silkstone	28/- to 29/- —
Derbyshire Best Brights	28/- to 30/- —
" " House	25/- to 27/- —
" " Large Nuts	24/- to 25/- —
" " Small "	18/6 to 20/6 —
Yorkshire Hards	23/- to 24/- —
Derbyshire "	21/6 to 23/6 —
Rough Slacks	12/6 to 15/6 —
Nutty "	12/- to 14/- —
Smalls	8/- to 10/- —
Blast-furnace Coke (Inland) *	
" " (Export) f.o.b.	27/- to 28/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	27/9 to 28/3
Second " "	27/- to 27/6
Best Dry Large	26/6 to 27/-
Ordinary Dry Large	25/- to 26/-
Best Black Vein Large	26/6 to 27/-
Western Valley "	28/- to 26/6
Best Eastern Valley Large	25/- to 26/-
Ordinary " "	24/- to 25/-
Best Steam Smalls	18/- to 18/6
Ordinary "	16/6 to 18/-
Washed Nuts	25/- to 27/-
No. 3 Rhondda Large	28/- to 29/-
" " Smalls	24/- to 25/-
No. 2 " Large	24/6 to 25/6
" " Through	21/- to 23/-
" " Smalls	16/- to 17/-
Coke (export)	50/- to 55/-
Patent Fuel	29/- to 30/-
Pitwood (ex ship)	28/- to 30/-
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	47/6 to 50/-
Seconds	42/6 to 45/-
Red Vein	30/- to 32/6
Machine-made Cobbles	57/6 to 62/6
Nuts	52/6 to 60/-
Beans	42/6 to 45/-
Peas	27/- to 28/-
Breaker Duff	9/3 to 9/6
Rubbly Culm	15/- to 16/-
Steam Coals:	
Large	24/- to 26/-
Seconds	22/- to 24/-
Smalls	15/- to 19/-
Cargo Through	18/- to 22/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow.

(8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

*Blast-furnace Coke (Inland): Special Price for Ironworks 23/-, open market 27/- (at ovens). † Latest quotations available. (*a*) Delivered Sheffield or Glasgow. (*b*) Delivered Birmingham.

French Engineering Notes.

(*From our Correspondent in Paris.*)

Motor Cars.

THE motor car industry has been specially favoured by the peculiar economic conditions in this country, which have enabled manufacturers to produce at relatively low cost and sell in markets with normal currency, even when burdened with duties to compensate for the difference in money values. Some firms, however, have passed through trying times on account of relying too much upon the expected vogue of the cyclecar. Until recently a large business was done in these vehicles, but the usual evolution has taken place in the direction of higher-powered cars, the owners of cyclecars generally finding that they are inadequate and preferring, therefore, a type of light car capable of carrying heavier loads. The success of the small cars that have been put on the market by such firms as Citroën and Renault is encouraging nearly all the big makers to prepare for the introduction of light vehicles propelled by engines of nominally 6 or 7 horse-power. The interest of this new departure lies in the fact that the new engines will run at very high speeds. One of the oldest and best-known firms in the world is testing a small engine running at 4500 revolutions per minute with a view to the introduction of a light car, probably at the next Salon. Another important firm does not expect to be able to present its new small car in less than two years. The designing and tuning up of these phenomenally high-speed engines present many difficulties, and had they been easier such engines would have been introduced long ago, for one Belgian maker carried out road tests before the war with an engine running at close on 5000 revolutions per minute. Since then the normal angular velocities have been increasing, and with the experience acquired it appears as if a number of firms were now fairly assured of getting the maximum efficiency for small engines at somewhere between 4000 and 5000 revolutions per minute. The result is to reduce considerably the weight per horse-power, and at the forthcoming Salon there will probably be seen a four-seater light car with an engine rated at 6 horse-power but capable of developing four times that power. If the tendency is in the direction of building small cars with engines of very high angular velocities there appears to be no falling off in the construction of bigger vehicles, and this branch of the industry has been greatly extended by aviation firms taking up the building of cars as a means of utilising manufacturing resources that are otherwise only employed intermittently. Where plant exists for the turning out of aviation engines it can be used for the construction of car engines, and the influence of aviation engineering upon automobile engine design is becoming more and more marked. One aviation firm is now turning out a first lot of chassis with six-cylinder engines developing 55 horse-power at 3200 revolutions per minute. This striving after light engine efficiency is one of the most striking features of the automobile industry.

Industrial Cars.

The industrial branch of the motor car industry is progressing steadily, and is coming more and more into the hands of firms which specialise in their construction. The market is relieved of the burden of the huge stocks of American lorries, which are now entirely absorbed and are in many cases rejected through the difficulty of procuring spare parts. On account of the monetary situation, which practically excludes the importation of lorries, the business is entirely in the hands of French makers, and there are now scarcely any British vehicles, while the steam lorries which were formerly imported from England have disappeared altogether. The present cost of coal and coke has proved fatal to the steam wagon, while the national propaganda in favour of replacing solid by liquid fuels partly produced in the country, is a still more powerful factor in sealing the fate of steam on the road. The war stocks also left in this country some hundreds of American petrol locomotives which are being disposed of occasionally and are employed by public works contractors and in the Colonies, but the great majority of them are stranded in the aviation and other centres, where, through lack of maintenance, they are rapidly losing all chance of useful work. Nevertheless, the petrol locomotives have proved their usefulness, and they were largely responsible for the efforts that were made last year to run petrol locomotives and rail motors on local railways. A number were put into service, but little has been heard of them since, from which it may be concluded that exhaustive tests will be carried out before the railway companies decide to adopt them on any extensive scale.

Cartels.

Last year the efforts to establish a cartel by the British and continental iron and steel firms failed because it was found impossible to fix upon a ratio satisfactory to all concerned. It is hardly likely that much better results will attend similar negotiations now being carried out by the rod and strip firms. Nevertheless, it is becoming more and more evident that something will have to be done to organise the industry, which is drifting rapidly in the direction of reckless competition. While the territorial changes have upset completely the distribution of metallurgical resources and have enormously increased those belonging to this country, the phenomenal development of the iron, steel and engineering trades has placed French makers in the position that they must eventually look abroad for business. Already the idea is gaining ground that the future lies in a stringent manufacturing economy and in selling at the lowest possible prices compatible with a reasonable profit. The situation is further complicated by the fact that in January next Germany will be freed from the economical restrictions imposed upon her by the Treaty of Versailles and will therefore be at liberty to place heavy duties on French products, as well as on goods from Alsace-Lorraine, which depends upon Germany as the principal market. The result will necessarily be the signing of treaties of commerce between Germany and other countries, and France will be obliged to adapt her commercial policy to the new state of things, which implies a readjustment of markets and an attempt on the part of each producing country to minimise as much as possible the effects of foreign competition.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

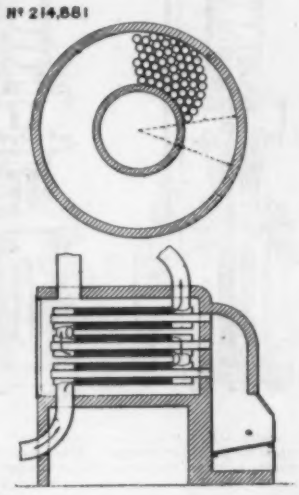
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

214,881. July 9th, 1923.—SUPERHEATERS, A. d'Herbelot, 42, Rue de Grenelle, Paris, and C. Maiche, 18bis, Rue de Bezons, Courbevoie (Seine).

The inventors propose to increase the effectiveness of the heating surface of superheaters by stuffing the tubes through which

Nº 214,881



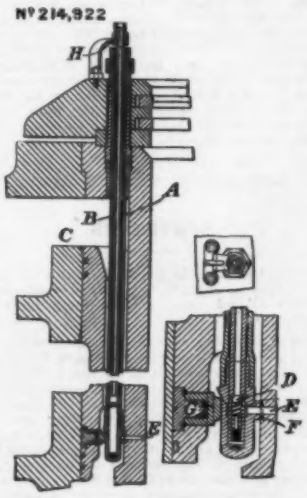
the steam passes with very small tubes of, say, 8 m. in diameter. These fine tubes are pressed into the annular space between two concentric tubes, which forms the passage for the steam, and the heating gases pass both through the inner tube and round the outside.—*May 1st*, 1924.

INTERNAL COMBUSTION ENGINES.

214,922. November 14th, 1923.—LUBRICATING CYLINDERS, Palmers Shipbuilding and Iron Company, Limited, and D. Kemp, Hebburn-on-Tyne.

This invention relates to the lubrication of the cylinder liners of opposed-piston type engines and aims at making the reflux valve on the end of the lubricating pipe more accessible. A is the oil pipe, and it is surrounded by a sleeve B to shield it from

Nº 214,922



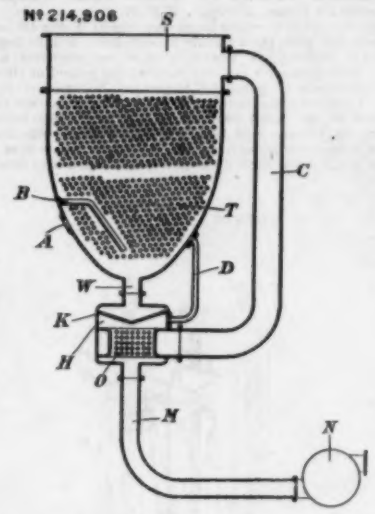
the cooling water in the jacket C. D is the reflux ball valve and E the passage for the oil into the cylinder. The facing F on the end of the oil pipe is pressed up against the cylinder liner by the stud G, and the pointer H shows when the two are in the proper relative positions. When necessary, the pipe A can be withdrawn from the sleeve B, bringing with it the valve D, without disturbing the remaining parts.—*May 1st*, 1924.

CONDENSERS AND FEED-WATER HEATERS.

214,906. September 10th, 1923.—SURFACE CONDENSERS, G. and J. Weir, Limited, Cathcart, Glasgow, and J. G. Weir.

The inventors aim at withdrawing the condensate from the condenser at as high a temperature as possible, and for this purpose take it through a heater warmed by part of the exhaust. The inlet for exhaust steam is at S, and A is the air withdrawal port. This port is placed behind a baffle B which is arranged as shown. W is the water withdrawal port whereby the condensate flows from the condenser into the heater H. The steam is led to the heater by the conduit C from the top of the condenser above the uppermost row of tubes. The steam from the conduit is admitted to the heater through the perforations O, and the condensate is sprayed into the heater through the perforated plate K; the water, mingling with the steam, becomes heated thereby, and the heated water is withdrawn through the pipe M by the pump N. D is a pipe leading from the heater to the condenser. Through this pipe air, separated from the steam in the heater by the action of the water, is withdrawn to the condenser. The pipe D, it will be noted, is led to the side of the condenser

Nº 214,906



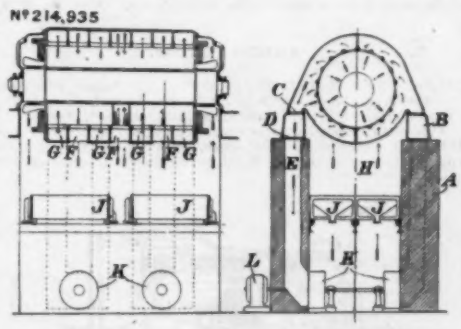
other than that containing the air withdrawal port A. This is to ensure that the air withdrawn through the pipe D (which is relatively hot) will pass over relatively cold surfaces before gaining access to the port A.—*May 1st*, 1924.

DYNAMOS AND MOTORS.

214,935. October 24th, 1922.—IMPROVEMENTS IN AND RELATING TO COOLING AND VENTILATING OF DYNAMO-ELECTRIC MACHINES, The British Thomson-Houston Company, of Crown House, Aldwych, W.C. 2, and Henry William Taylor, of St. Mark's-avenue, Old Belton, Rugby.

According to this invention the circulating air is admitted through apertures formed in the bottom of the casing of the machine in addition to being admitted at the ends of the casing. The casing of the machine is mounted on a foundation A by means of a hollow base plate B. The base plate communicates at its upper face through apertures C, with corresponding discharge apertures in the seating of the casing and at its lower face through apertures D with air ducts E in the foundation. Air is admitted into the casing at each end and at alternate longitudinal compartments F, and is discharged from the remaining longi-

Nº 214,935



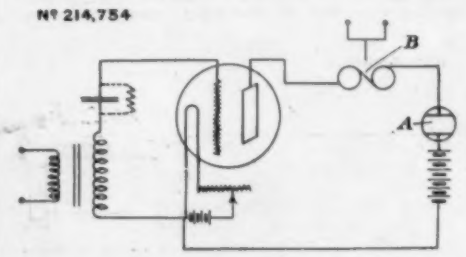
tudinal compartments G, the air paths being indicated by arrows in the drawing. Directly under the machine there is a chamber H containing air coolers J in the foundation, and the lower end of the ducts E open into this chamber. At the points where the air passes from the ducts E into the chamber H fans K operated by motors L are provided for dealing with the quantity of air required and supplying it under the necessary pressure to chamber H. The air passes downwards through the ducts E on each side and is propelled by the fans into the chamber H through the coolers J and re-enters the casing through the end and intermediate inlets. The coolers may be so situated that the air from the casing passes through them before being propelled in its forward path by the fans, but preferably the air passes through the fans before reaching the coolers.—*April 24th*, 1924.

TELEGRAPHS AND TELEPHONES.

214,754. February 6th, 1923.—A METHOD OF MAGNIFYING INTERMITTENT ELECTRICAL IMPULSES, Horatio St. George Anson, of Pixham Mill House, Dorking.

The arrangement described in this specification is said to be particularly useful in connection with wireless apparatus

Nº 214,754



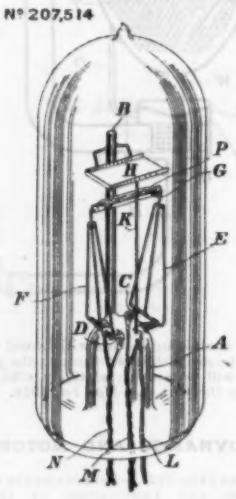
when it is desired permanently to record the messages instead of merely listening to them. The inventor states that the chief difficulty in permanently recording messages is that of providing a suitable resistance for the earth circuit of the recording relay without producing a deleterious effect upon the valve or without detriment to its sensitivity. According to the invention a neon

lamp A and a vibrating relay B are connected in series in the plate circuit of the last valve of the receiving set.—*May 1st*, 1924.

207,514. October 29th, 1923.—IMPROVEMENTS IN ELECTRON DISCHARGE DEVICES, *The Western Electric Company, of Connaught House, Aldwych, W.C. 2.*

In vacuum tubes in which large amounts of power are handled it is desirable that the cathode should have a high degree of thermionic activity at relatively low temperatures and be capable of retaining its activity over a long period of time with large differences of potential impressed between it and the anode. Power tubes, according to this invention, have a cathode composed of the metal uranium, which has a relatively high melting temperature and relatively low rate of volatilisation, and has a thermionic activity of the same order as that of the alkaline earth oxide coated cathodes, and which also retains its

Nº 207,514



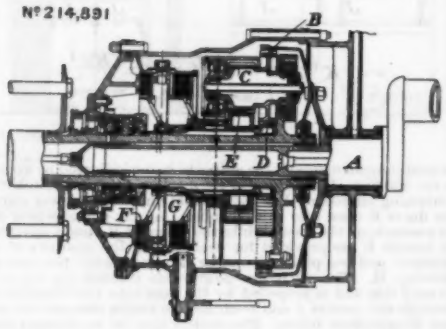
activity when subjected to high voltages. A glass containing vessel is provided with a re-entrant stem A with an arbor B. Sealed in the end of the stem are metallic members C and D which support the wire frames E and F, one wire of each frame projecting beyond the end of the frames. A boat or vessel G composed of molybdenum is electrically connected to and supported by the wires projecting beyond the ends of the frames. A plate H is supported directly above the boat G and is connected by means of a wire K to a lead wire L. Lead-in wires M and N are connected to the members C and D respectively. In the boat G a supply of finely powdered uranium P is placed, this metal having a higher melting temperature and lower rate of volatilisation than platinum and having a thermionic activity of the same order as the alkaline earth oxides.—*May 1st*, 1924.

AERONAUTICS.

214,891. July 23rd, 1923.—CHANGE-SPEED GEAR FOR AERO ENGINES, A. J. Rowledge, Ellerslie, Trowels-lane, Derby, and Rolls-Royce, Limited, Nightingale-road, Derby.

This change-speed gear is of the epicyclic type in which all the gear wheels are always in mesh. A is the crank shaft of the engine, and on it there is fixed an internally toothed ring B.

Nº 214,891



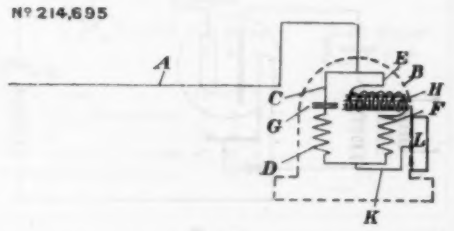
This ring meshes with the planet wheels C, which have teeth of two diameters. These planet wheels work round two sun wheels D and E mounted on sleeves. These sleeves also carry plate clutches F and G, either of which can be engaged to hold one of the sun wheels and put the corresponding gear in action.—*May 1st*, 1924.

MISCELLANEOUS.

214,695. January 17th, 1923.—IMPROVEMENTS IN ELECTRICALLY OPERATED SOUND SIGNALLING INSTALLATIONS, *Harold Baron, of Crown House, Aldwych, W.C. 2.*

This specification describes a submarine sound transmitting installation operated with alternating current through a single-

Nº 214,695

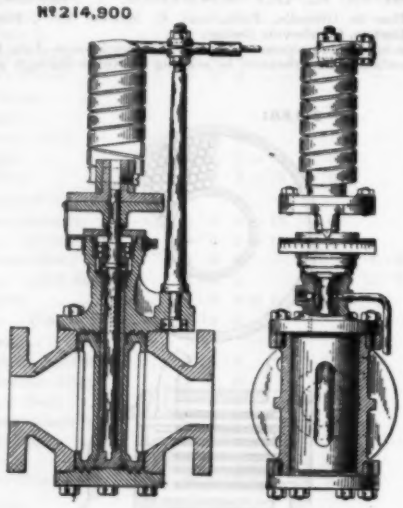


core cable with an earth or water return. The invention applies particularly to installations in which a direct-current winding is provided on the transmitter for polarisation. In the diagram the single-core cable A conducts direct and alternating current to the sound transmitter B. The cable is led into the transmitter casing, which is indicated by the dotted lines, and it branches into an alternating-current lead so as to supply the alternating current coil D and a direct-current lead E supplies the direct-current winding F, which produces a constant magnetic field. In series with the alternating-current lead there is a condenser G and a choke coil H is connected in series with the direct-current coil. The free ends of the coils D and F are joined to the conductor K which is connected to the earthing body L on the outside of the transmitter casing. In this way the single-core cable is used for carrying both the polarising current and the operating current.—*April 17th*, 1924.

214,900. August 25th, 1923.—THERMOSTATS, J. Gordon and Co., Limited, and C. M. Ferguson, Windsor House, Kingsway, London, W.C. 2.

According to this invention a Bourdon tube thermometer preferably in the form of a cylindrical helix, has one end operatively attached to the spindle of a rotary valve controlling ports in a valve casing. The valve is conveniently of the balanced

Nº 214,900



type and is constructed so that it can rotate freely in its casing when acted upon by the Bourdon tube. The connection between the valve spindle and the Bourdon tube is preferably through some convenient form of two-part coupling which will allow the apparatus to be set so that the valve may be opened by the action of the tube at various predetermined temperatures. The drawing is self-explanatory.—*May 1st*, 1924.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. SIDNEY R. LOWCOCK, of 6, Queen Anne's-gate, S.W. 1, has been elected chairman of the Committee of the Association of Consulting Engineers for the ensuing year.

MESSRS. JOHN STERLING AND CO., of 66, Victoria-street, Westminster, S.W. 1, ask us to state that they have taken into partnership Mr. A. Woodward, M.I. Mar. E.

AFTER nearly twenty-six years as vice-principal of the Crystal Palace School of Practical Engineering and a like period as principal, Mr. J. W. Wilson, M. Inst. C.E., M.I. Mech. E., past president of the Society of Engineers, has announced his retirement at the close of the present term. He will be succeeded in the principalship by his brother, Mr. Maurice Wilson, A.M. Inst. C.E., F.S.E., past president of the Society of Engineers, who has been the vice-principal for the past twenty-six years. It will be remembered that this School was founded by Mr. Wilson, sen., in the year 1872, since which time over 1300 students have succeeded in the profession, many of whom occupy high positions therein at the present time.

CONTRACTS.

JOHNSON AND PHILLIPS, Limited, of Charlton, London, S.E. 7, have just received an order from the Sydney Municipal Council for four 6200 kilovolt-ampère three-phase forced oil-cooled transformers.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, Limited, has received an order from the Southern Railway Company for cable for the electrification of its South-Western suburban lines, between Raynes Park, Epsom, Leatherhead, Effingham Junction, Clandon, Guildford, Dorking, Hampton Court and Oxshott. The total length of cable involved amounts to more than 60 miles, and the cables are 0.2 square inch, 0.15 square inch., 0.1 square inch, and 0.06 square inch, extra high-tension 3-core paper insulated, lead-covered and single wire armoured for a working pressure of 11,000 volts. The contract is for the supply, jointing and connecting up of the cables.

THE contract for the reconstruction of the Tokyo telephone system, which was utterly destroyed in the recent earthquake, has been awarded to the Nippon Electric Company, Limited, of Tokyo, an associate company of the Western Electric Company. The entire system is to be of the Strowger automatic type and will be manufactured in England jointly by the Western Electric Company, Limited, of London, and the Automatic Telephone Manufacturing Company, Limited, of Liverpool. The initial order covers an equipment of 25,000 subscribers' lines to be installed in five offices, with trunking equipment in two other offices to enable the subscribers on the new automatic exchanges to reach the subscribers on the remaining existing manual exchanges. The value of the initial contract now placed is about three-quarters of a million sterling, and the entire reconstruction programme will involve the building of about 25 new exchanges in due course.

THE INSTITUTE OF PHYSICS.—At the annual general meeting of the Institute of Physics, held on May 26th, Sir Charles A. Parsons, K.C.B., F.R.S., was re-elected president. The vice-presidents are Professor W. H. Eccles, F.R.S., Mr. C. C. Paterson, Dr. E. H. Rayner, and Sir Napier Shaw, F.R.S. Sir Robert Hadfield, F.R.S., is treasurer, and Professor Alfred W. Porter, F.R.S., honorary secretary.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

BRITISH EMPIRE EXHIBITION, WEMBLEY.—Conference of Engineering Societies, in Conference Hall No. 4. Papers: "The Channel Tunnel," by Messrs. E. Benedict and E. J. Flight; "Sanitation and Water and Gas Supply at the British Empire Exhibition," by Mr. R. Freeman-Matthews; "Pumping in Relation to Irrigation," by Mr. A. Honeysett; "Surveying and Pioneer Road Work in West Africa," by Mr. G. V. Mathieson. 10.30 a.m.

RADIO SOCIETY OF GREAT BRITAIN.—Institution of Electrical Engineers, Savoy-place, London, W.C. 2. Informal meeting of the Transmitter and Relay Section. Lecture, "Modulation Systems," by Captain A. G. St. Clair Finlay. 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "The Glow of Phosphorus," by Lord Rayleigh. 9 p.m.

TUESDAY TO SATURDAY, JUNE 10TH TO 14TH.

ASSOCIATION OF MINING AND ELECTRICAL ENGINEERS.—Annual meeting in London. Headquarters, Midland Grand Hotel, St. Pancras, N.

WEDNESDAY, JUNE 11TH.

RADIO SOCIETY OF GREAT BRITAIN.—Institution of Electrical Engineers, Savoy-place, London, W.C. 2. Informal meeting. "General Observations on the Radio Situation and the Development of Broadcasting in New Zealand," by Mr. A. H. Ninnis. 6.30 p.m.

WEDNESDAY TO FRIDAY, JUNE 11TH TO 13TH.

INSTITUTION OF WATER ENGINEERS.—Summer meeting at Coatbridge and Glasgow. For programme see page 598.

WEDNESDAY AND THURSDAY, JUNE 18TH AND 19TH.

NEWCOMEN SOCIETY.—Summer meeting at Shrewsbury.

TUESDAY TO SATURDAY, JUNE 24TH TO 28TH.

INSTITUTION OF NAVAL ARCHITECTS.—Summer meeting in London. For programme see page 628.

WEDNESDAY TO SATURDAY, JUNE 25TH TO 28TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Annual general meeting in London. For programme see page 551.

THURSDAY, JUNE 26TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Natural History Museum, South Kensington, London, S.W. 7. Annual conversazione. 8.30 p.m.

SATURDAY, JUNE 28TH.

MANCHESTER GEOLOGICAL AND MINING SOCIETY.—Excursion to Castleton, Derbyshire, under the leadership of Professor Owen T. Jones.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—The £50 prize placed at the disposal of the Institution of Automobile Engineers by the Humber Company and allocated by the Council for the paper which would best enable the British manufacturer to regain the colonial market, has been awarded jointly to Mr. F. A. S. Acres for his paper entitled "The Requirements of the Colonial Market" and to Mr. E. A. Rouch for his paper entitled "The Overseas Automobile Market." The paper by Mr. Acres will be read at a special conference to be held in No. 3 Conference Hall at the British Empire Exhibition on Monday, June 23rd, at 11.30 a.m., and that by Mr. Rouch at 3 in the afternoon of that day in the same hall.

GALVANISED STEEL WIRE STRAND FOR SIGNALLING PURPOSES.—In the British Engineering Standards Association's Specification No. 163-1924, which has just been issued, are set out the conditions governing the supply of 7/17 S.W.G. galvanised steel wire strand for signalling purposes. The document includes a number of definitions and clauses relating to such matters as construction, material, dimensions, lay and inspection. With regard to galvanising it is laid down that the zinc used shall contain not less than 97.75 per cent. pure zinc. These clauses are followed by particulars of the tests which the wire is required to pass, including the method of taking the test samples, twisting, elongation and tensile tests, also dipping and coiling tests to prove the quality of the galvanising. The specification concludes with directions as to the coiling, marking and packing of the accepted materials and a table giving the percentage elongation, breaking loads, &c., for 17 S.W.G. wires of various tensile strength. Copies of this publication are obtainable from the B.E.S.A., Publications Dept., 28, Victoria-street, S.W. 1, price 1s. 2d. post free.

OLD CROMPTONIANS' DINNER.—A dinner was given by Old Crompotonians on the 31st ult. at the Royal Automobile Club, to commemorate the eightieth birthday of Colonel R. E. B. Crompton, C.B., who was the guest of the evening, and a silver salver, with a suitable inscription, was presented to Colonel Crompton from a number of old Cromptonians. Mr. A. A. Campbell Swinton, F.R.S., chairman of Crompton and Co., Limited, gave some interesting reminiscences of his first meeting Colonel Crompton at Chelmsford during some projector tests for Chilean ships, built by Sir W. G. Armstrong, Whitworth and Co. He also spoke of the Colonel's wonderful energy during a bicycle tour in France with a number of distinguished engineers. Mr. Swinton also stated that the directors of Crompton and Co., Limited, had decided to form an old Cromptonian Society, and a committee consisting of Messrs. J. Swinburne, E. Reeves, E. J. Fox, A. E. Mohring, and C. S. Peel as hon. secretary would meet immediately to discuss the possibility of the first meeting at a luncheon at Crompton's works at Chelmsford. Some interesting remarks were made by Mr. A. P. Lundberg, who was Crompton's first employee, and who is ninety-one years of age; and also by Mr. S. Baynes, who was the second employee. Mr. Charles Crompton, the chairman of the Stanton Ironworks, also spoke, together with E. J. Fox, managing director of the Stanton Ironworks, C. S. Peel, managing director of the "Field Press," J. W. Meares, C. F. Tufnell, S. Mavox, and A. Williams.